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SOILS: TOTAL ORGANIC MATERIAL

SHADY BEACH FIRE RECOVERY PROJECT
OAKRIDGE, OREGON
By
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Don Boyer, Soil Scientist and David Murdough, Soil Scientist

INTRODUCTION

The calculation of total organic material (TOM) was developed to assess the effects of the wildfire and various management strategies on the soil/site productivity. Forest soil/site productivity is dependent on the addition of organic materials to the nutrient cycling processes. Nitrogen, the most limiting nutrient in the forest soils of the Pacific Northwest, is mineralized or made available by the biological decomposition of organic materials such as woody debris, needles, twigs, leaves, and other dead plant materials. Decomposed organic materials are referred to as organic matter or humus. Organic material and humus also aid in soil-moisture retention, soil-aggregate stability, and surface-soil protection from erosion and rainfall impact. TOM is the measure of organic material plus humus. TOM components include down and standing organic material such as green and decaying trees, shrubs, herbs, soil duff, forest-floor litter, downed-dead wood, soil-organic matter, and plant roots.

The following treatise describes the process utilized to estimate the amounts of pre-fire and post-fire organic materials and to analyze the effects of different land management alternatives on TOM for the Shady Beach Fire Recovery project. The outline that follows describes the pre-fire and post-fire process for calculating TOM. Immediately following the pre-fire and post-fire outline is an overview of the process that describes in more detail the steps of the process, observations, and assumptions used to calculate TOM. An outline and an overview that displays the TOM process for effects by land management alternatives follows the pre-fire and post-fire outline and process overview. This information should give the reader some insight into the TOM calculation process but for more specific details refer to the environmental analysis file, Rigdon Ranger District.

TOM Process Outline for Pre-fire and Post-fire Conditions

I. **Above-Ground Biomass**: Green and decaying trees, shrubs, and herbs.

   a. Converted TRI Stage II inventory data to biomass.
   b. Converted field-collected recovery project data to biomass. (Compared A and B for best representation).
   c. Grouped all stands into stylized stands utilizing stand inventory as refined by field data.
   d. Refinement of data by aspect, elevation, slope, and fire mortality.

II. **Ground-Level Biomass**: Soil duff, litter, and downed, dead wood.

   a. Data collection: field, district, publications.
   b. Generalized data into data base.
   c. Refinement of data by: aspect, elevation, slope, and fire mortality (fire intensity).

III. **Below-Ground Biomass**: Plant roots and soil organic matter.

a. Collected field data, verified observations and publications.
b. Stratified data by stylized stands.
c. Refinement of data by aspect, elevation, slope, and fire mortality.

TOM Process Outline for Pre-fire and Post-fire Conditions

Analysis Area: Shady Beach Fire area

I. Above-Ground Biomass: Green and decaying trees, shrubs, and herbs.

The Rigdon Ranger District's Stage II data, stored in Total Resource Inventory (TRI), was utilized to develop biomass above ground for all inventoried trees. Snell and Brown (1980) was used in conjunction with the District's Stage II data. The outputs are displayed as tons of generated logging slash in size categories of diameters less than 3 inches and greater than 3 inches. These biomass loading models assume limbs and unmerchantable tops from harvested trees, excluding merchantable logs, defect, and breakage. Merchantable logs are listed as cubic feet volume in the Stage II data base, because such biomass was estimated by multiplying cubic feet by 30 pounds per cubic foot.

The above-described method was cross verified with project-collected stand data. Biomass predictions utilizing data which appears in the Geographic Information System (GIS) data dictionary were difficult to obtain and required a significant increase in the number of assumptions incorporated into the calculations. Comparison of Stage II versus data dictionary biomass estimating methods revealed a variation of +/- 16 percent. For these reasons the Stage II data method was implemented.

Non-inventoried shrubs were estimated utilizing Ghloz (1979) for biomass.

The unmanaged forest within the project area was stratified into six stylized stands. Stand characteristics are defined in Figure A-1.

Stand	Stand Characteristics
1	Old-growth, diameter breast height (DBH) 24 to 61 inches, may have a minor understory component.
2	Commercial thin with scattered overstory, DBH 6 to 26 inches with few scattered 30+ inches.
3	Commercial thin with understory, DBH 10 to 26 inches, has appreciable understory stocking in the seedling/sapling size.
4	Commercial thin, DBH 10 to 22 inches, fairly thrifty stand with minor components of seedling/sapling or overstory trees.
5	Commercial thin, DBH 10 to 32 inches, this stand could be classified as an old-growth stand or as a two-storied stand. Differentiation over Stand 4 will be an increase in volume.
6	Three-storied, fully-stocked, significant stocking of all layers present: seedling/sapling (DBH 2 to 6 inches), DBH 8 to 21 inches, and DBH 22 to 56 inches.

Figure A-1 Stand characteristics

These stylized stands were sorted by aspect, elevation, slope, and mortality (intensity). GIS was utilized to perform the sorts and derive acreage figures for each final sort. This sorting process created 32 subdivisions per stand.

Definitions of the criteria:

1. Aspect
   N = NW, N, NE, E, and SE.
   S = S, SW, W.

2. Elevation
   Greater than or equal to 2,800 feet.
   Less than 2,800 feet.

3. Slope
   Greater than 40 percent.
   Less than or equal to 40 percent.

4. Mortality
   High = dead, outright fire-killed.
   Moderate = Scorch evident but not dead now; will probably die within 2 years.
   Low = Some scorch in seedling and pole size classes; most merchantable volume will survive.

Because biomass was estimated on a stand basis, the range of loadings are quite different than those expressed in the Silver Fire Recovery EIS. However, if biomass estimates were calculated for a smaller scale area, the range would more closely align with the Silver Fire data. Biomass for the stylized stands was estimated as described above and field-verified. During field verification, several trends were noticed.

1. Old-growth above 2,800 feet in elevation exhibited a higher degree of decadence. The fire removed approximately one tree crown per 10 old-growth trees, the crown burned off at approximately the 16-inch diameter level. The result was removal of 0.5 ton from the above-ground to the ground level. This is generally true for the old-growth above 2,800 feet and for south aspects below 2,800 feet in elevation.

2. Fire intensity, recorded as fire mortality, has removed foliage from the crowns. In areas of crown fire, the foliage has been consumed. In areas of scorch, the foliage will fall to the ground as needle cast, again removing biomass from the above-ground to the ground levels.

3. Slopes less than 40 percent have an increased shrub component, generally 2 to 4 tons per acre.

4. Southerly aspects have an increased shrub/hardwood component below 2,800 feet elevation, ranging from 2 to 8 tons per acre.

These trends are accounted for in the final computation of above-ground biomass.

Managed stands (plantations) within the project area were subdivided according to age, in 5-year increments; 0-5, 6-10, 11-15, etc. This created an additional seven stylized stands. Units currently under timber harvest contract, or logged but not yet planted, were considered to be Age "0". Again the residue prediction method (Snell and Brown, 1980) was utilized to predict above-ground biomass. All plantations were assumed to be fully stocked, 600 trees per acre, until pre-commercial thinning at Age 10 to 15 which reduced stocking to 260 trees per acre.

II. Ground Biomass: Soil duff, litter, and downed-dead wood.

Field verification of ground biomass revealed several trends.

1. Duff depth on north aspects ranged from 1 to 3 inches (greater duff accumulations were present only at the higher elevations), whereas south aspects were rarely over 1 inch in depth. A combination of slope and fire intensity are employed to calculate duff consumption. Slopes greater than 40 percent are indicative of a totally consumed duff layer; slopes less than 40 percent have varying amounts of duff remaining. Calculations using the computer program CONSUME indicate that 4 inches of duff consumption were possible. A standard of 18.6 tons per inch of duff was utilized.

2. Existing biomass by stylized stand was estimated using Maxwell and Ward (1976) and Snell and Brown (l980). A combination of photo series was commonly employed to quantify the greater-than-3-inches diameter class, the less-than-3-inches diameter class, and logs. Biomass consumption of logs larger than 9 inches was estimated by converting associated volume losses to tons (McArdle 1961 volume tables, 6 board feet equal 1 cubic foot).

III. Below-Ground Biomass: Plant roots and soil organic matter.

The plant root portion of the below-ground biomass was estimated using Wenger (1984). The amount of reduction by fire remains a difficult estimation and employs Wenger (20 percent of above-ground biomass, equates to the below-ground root biomass) and field observations that demonstrated very little below-ground biomass having been consumed (only decomposed stumps burned deeply). Only stylized Stands 2, 3, and 5 showed appreciable reductions in root biomass, and were restricted mostly to north aspects.

Managed-stand root biomass estimates included existing crop tree and shrub root-mass plus the root biomass of the previous stand (harvested timber). An average root biomass from stylized stand types 1 through 6 was universally applied to all managed stands. Below-ground organic matter was estimated by summing the root biomass from existing and previously existing stands.

The soil organic matter was calculated from Oregon State University soil test results. All soil sampling was done on the Shady Beach Fire Recovery Project area. Soil samples from eight locations in Hills Creek Watershed 122C were collected and analyzed for soil organic matter (see Figure A-2). Samples were collected and data was stratified by depths of 0 to 4, 4 to 8, and 8 to 12 inches on similar soils but with contrasting aspects, in the range of 2,600 to 3,200 feet elevation. All sample locations were in the Soil Resource Inventory (SRI) Mapping Unit 333. However, the soils more closely resembled the 23 soils rather than the 33 soils, since all were reddish-brown and usually shotty, with the exception of the soil from the unburned, old-growth, north slope. (Refer to Shady Beach Recovery Project Analysis Files for specific organic matter sampling location characteristics.)

Soil Sample %	Organic Matter	Description
1-1 1-2 1-3	6.6 7-54 3.95	20-year-old plantation, Douglas-fir and ponderosa pine, south aspect, burned
2-1 2-2 2-3	6.45 5.88 6.03	20-year-old plantation, Douglas-fir reproduction clump, north aspect, burned
3-1 3-2 3-3	6.03 4.21 3.28	Old-growth, Douglas-fir, south aspect, burned
4-1 4-2 4-3	6.19 3.48 2.86	5-year-old plantation, Douglas-fir, south aspect, burned
5-1 5-2 5-3	6.81 4.37 2.61	5-year-old plantation, Douglas-fir, north aspect, burned
6-1 6-2 6-3	4.00 3.22 1.87	Old-growth, Douglas-fir, north aspect, burned
7-1 7-2 7-3	8.68 2.96 2.03	Old-growth, Douglas-fir, north aspect, unburned
8-1 8-2 8-3	7.7 7.85 3.02	Old-growth, Douglas-fir, southwest aspect, unburned

Figure A-2 Oregon State University lab results for soil organic matter contents in burn area

Realizing that a single sample analysis is insufficient for developing a conclusion, a trend does seem apparent. Experience along with this apparent trend indicates that there is a correlation between burn intensity and soil organic matter. The light burn that occurred on the south slope of the 20-year-old plantation and the south slope of the old-growth had 14 and 22 percent less soil organic matter in the top 4 inches of mineral soil respectively than the south-facing, unburned old-growth site. The moderate burns that occurred on the north-slope, 20-year-old plantation, had 25 percent less soil organic matter than the north-facing, unburned site. The moderate-to-high burn intensity that occurred on the south-facing, 5-year-old plantation had 19.6 percent less than the south-facing old-growth (see Figure A-3).

Stand Age/Type	Aspect	Average Percent of organic matter (0 to 12 inches)
5-year-old Plantation	North South	4.6 4.18
20-year-old Plantation	North South	6.12 6.03
Old-growth	North South	3.03 4.51
Unburned Old-growth	North South	4.56 6.19

Figure A-3 Average organic matter contents for surface soils

In summary, it appears that the soil organic matter content in the 0 to 4 inch layers are greater on the north slopes than the south slopes, but the combined 0 to 12 inch layers indicate the opposite condition. This seems plausible since soil-moisture and soil-temperature optimum levels for decomposition of woody materials would start earlier in the season on the south slope while the north slope soil-moisture conditions may last longer. The higher soil temperatures would not be reached until late in the growing season and possibly at the same time moisture depletion by transpiration would occur. At any rate, the laboratory analysis does support the concept that the majority of the humus-related contributions to forest productivity is confined to the top 4 inches.

Assuming that the forest mineral soil would have an average bulk-density value of 0.8 gms/cc (Little and Klock, 1985), an acre foot of soil would weigh 2,175,560.6 lbs. or 1,087.78 tons (43,560 sq. ft. X 62.43 lbs/ cu. ft. = 2,719,450.8 lbs./ac. 2,719,450.8 lbs./ac. X 0.8 = 2,175,560.6 lbs./cu. ft.)

Organic matter calculations for below-ground contributions could be adjusted for north-facing and south-facing forested slopes within a given elevation range of about 1,500 to 3,000 feet and within various burn categories. Figure A-4 reflects the rates to be used for the below-ground soil organic matter portion of TOM.

Burn Intensity	North Slope	South Slope
High	60 tons (5.5% Organic Matter)	55 tons (5.0% Organic Matter)
Moderate	76 tons (7.0% Organic Matter)	71 tons (6.5% Organic Matter)
Low	82 tons (7.5% Organic Matter)	76 tons (70% Organic Matter)
Unburned	88 tons (8.0% Organic Matter)	82 tons (7.5% Organic Matter)

Figure A-4 Percentage of below-ground soil organic matter of TOM

TOM Process Outline for Land Management Alternative Comparison

I. **Biomass Removal as related to Alternatives.**

a. Determine total volume and variety of harvest prescriptions and relate to fuels treatment.
b. Utilize average values of above-ground organic material and ground material components within the fire perimeter (excluding private lands and rock outcrops).
c. Compute TOM removal by harvest and fuels treatment.

II. **Total Remaining Biomass.**

a. Determine acreage of each harvest prescription and fuels treatment.
b. Combine amount removed above-ground organic material and ground organic material component contribution.
c. Add volume left for streamside management units and wildlife habitat.
d. Compare total remaining tonnage to total post-fire tonnage.

TOM Overview for Land Management Alternatives

The process of developing TOM values for each alternative considered an average value for the above-ground and ground-level components. Since post-harvest fuel treatment was to be accomplished by prescription and a large percentage of the fine fuels have already been consumed in the fire, it was determined that there would be no additional change in the below-ground component. The majority of the existing TOM tonnage would be lost from the site by removal of merchantable timber. However, the logging slash (tree tops, limbs, etc.) and the remaining shrubby understory species represent an organic material contribution that could be manipulated through refined fuels prescriptions. The expected fuel loadings, after timber salvage, range from 50 to 95 tons per acre. The Rigdon Ranger District goals, following the guidelines in the Current Forest Plan/FEIS, are to reduce the fuel loadings to 45 tons/acre. Therefore, fuel treatments such as broadcast burning could be required in some of the clearcut units that exceed the 45 tons/acre target values or represent a significant fire hazard and some fuel treatments could be expected in some of the partial cut units.

The determination of the anticipated changes in TOM can be illustrated by the following example:

Alternative B Recommends:

	Acres	Prescription
	1,460	No Harvest.
	3,001	Harvest by Clearcutting Practices.
	1,694	Harvest by Partial Cutting Practices.
Total	6,155	

Of this acreage, fuel treatment will vary from "no treatment required" to fuel treatments designed to reduce future fire hazards. Yarding of unutilized material was not considered in the fuels treatment and the removal of TOM was based on a normal utilization of 80 percent of the total volume in clearcuts and 40 percent in partial cuts. The shrub layer and small tree contribution was accounted for according to the harvest and fuels treatment in the remaining biomass category. Approximately 9.8 MMBF of timber will be left on-site for wildlife habitat and streamside management and was added to the total remaining biomass.

Figure A-5 illustrates the TOM prediction for Alternative B.

Harvest Method & Fuels Treatment	Average Post-fire Above Ground & Surface tons/acre	TOM Removal by Harvest & Fuels Treatment tons/acre	Remaining Standing Material	Biomass Surface Material
Clearcut & Broadcast Burn	206	190	3	45
Clearcut & No Treatment	206	173	3	62
Partial Cut & Underburn	206	81	133	24
Partial Cut & No Treatment	206	66	133	39

Harvest Method & Fuels Treatment	Acres	Organic Material Removed	Predicted Total Organic Material Removed
Clearcut & Broadcast Burn	2,146	190	-407,740
Clearcut & No Treatment	855	173	-147,915
Partial Cut & Underburn	119	81	-9,639
Partial Cut & No Treatment	1,575	66	-103,950
		Subtotal	-669,244
		Add Wildlife & SMU Volume	+24,500
		Total Organic Material Removed	-644,744

Figure A-5 TOM prediction for Alternative B

The post-fire organic material in the fire area totals 2,204,882 tons. The fire area predicted total remaining biomass, after harvest and fuels treatment, is 1,560,138 tons. This alternative results in a loss of 644,744 tons of organic material, whereas 67 percent of the post-fire TOM tonnage remains on-site with an average TOM of 206 tons per acre.

For the more complete version of TOM calculations, the reader may refer to the Shady Beach Recovery Project Analysis File, which is on file at the Rigdon Ranger District, Willamette National Forest, Oakridge, Oregon.

HYDROLOGY

SHADY BEACH FIRE RECOVERY PROJECT
OAKRIDGE, OREGON

By
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and
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Water quality and fish habitat in Hills Creek, its major tributaries, and in Hills Creek Reservoir are critical environmental concerns. This process paper documents the procedures that were undertaken by the Cumulative Effects hydrology team to evaluate important hydrologic concerns. An interdisciplinary approach was used in this analysis to integrate fisheries, soil, and water resources. The concerns were identified during the Information Needs Assessment, a process used to identify evaluation criteria for each resource.

HYDROLOGIC CONCERNS

1. The fire, logging, and roading of the subwatersheds in the project may give aggregate recovery percentages (ARPs) that increase streamflows.

2. Flow rates may be increased sufficiently to damage the channel and/or the critical reaches. (Frequency of the 10-to-20-year peak flow events may be changed).

3. Sediment yields may be increased due to loss of protective vegetation and soil organic material from fire, logging, and roading effects to the extent that fish habitats may be diminished.

4. Turbidity may be increased due to fire, logging, and roading to the extent that water quality standards for the streams are exceeded.

5. Increased sedimentation due to loss of vegetation and increased soil erosion and mass failures caused by fire, logging, and roading may shorten the effective life of Hills Creek Reservoir.

6. The destruction of shading vegetation caused by fire, logging, and roading may cause an unacceptable increase in the temperatures of the streams in the project area.

7. Increased erosion and streamflows caused by fire, logging, and roading may increase the bedload sediment to the extent that spawning and fry habitats for native resident fish are diminished.

ANALYSIS RESOLUTION

To allow for a more specific analysis, the designated Forest watersheds and subwatersheds were subdivided into subdrainages. This defined the drainage areas for small streams that are tributaries to Hills Creek and to Hills Creek Reservoir (including that portion that is on the Middle Fork of the Willamette River) and allowed for evaluation of impacts to each of the subdrainages independently. It also allowed impacts to be accumulated for evaluation at the subwatershed and watershed levels.

Listed below are responses for each hydrologic concern.

AGGREGATE RECOVERY PERCENTAGE (ARP)

This analysis was to evaluate ARP values for the subdrainages in the Project Area. ARP values are used as an index to estimate changes in streamflow, sediment yield, and turbidity (refer to Chapter III, Water-ARP), and are described in the Proposed Forest Plan/DEIS, page IV-12.

The ARP model was developed on the Willamette National Forest. The Rigdon Ranger District established that a drainage with an ARP of 75 percent or greater has not been seriously impacted in terms of increased water yield from rain-on-snow events nor from increases in sediment yield and therefore turbidity (Proposed Forest Plan/DEIS - page IV-26).

ARP values were used as one of the primary components to evaluate the alternatives. The ARP values were aggregated to the subwatershed and watershed levels. Each subdrainage was evaluated to describe the condition: 1) pre-fire, 2) post-fire, and 3) post-logging. In order to evaluate the total effect on Hills Creek, ARP was determined first for the total drainage including the portion of Hills Creek outside the project area. We computed an ARP value based on current conditions and expected ARPs for the next decade. These values were then weighted by the number of acres within the Subwatersheds 122 A, E, F, G, H, I, J, K, L, M, and N. They were then added to the weighted average ARP value which had been determined for each alternative. This gave the ARP for the total drainage. A LOTUS spreadsheet, developed at the Lowell Ranger District, was used to determine the ARPs for the part of Hills Creek watershed outside of the project boundary (S-shaped curve). Inside the project boundary, however, a straight line regression of the S-curve was used to calculate ARPs.

ARP was determined primarily from the age of the stand because of the importance of crown closure on ARP. At 28 years, a stand of trees is estimated to be recovered at 100-percent ARP with 70-percent crown closure. For fire-damaged stands, a Geographic Information Systems (GIS) Predicted Mortality Map was used in combination with stand age to determine ARP. Map cells were created by overlaying the Predicted Mortality Layer with the Stand Type Map and the Subdrainage Map. The ARP was determined for each cell and then accumulated to determine the ARP for the subdrainage.

The removal of dead trees was not considered a contribution to logging-related ARP reduction, because there would be no significant ARP value in standing dead trees. ARP reductions which would result from salvage logging of burned trees were made by estimating a 10-percent reduction in ARP caused by logging corridors through green stands.

The pre/post fire stand data and salvage plans were evaluated for each harvest stand. Changes in stand description as a result of the fire and of anticipated logging were made to determine the effects of the various alternatives on sediment, temperature, turbidity, and streamflow. These effects were evaluated for the subdrainages and then accumulated and extended to the subwatershed and watershed levels. Critical reaches along Hills Creek were also evaluated. The fire project area analysis was reported only for selected subdrainages and watersheds. These impacts were related to changes in the condition of fisheries habitat because it is the dominant consideration for water quality in this area.

STREAMFLOW

Streamflow was analyzed to determine the magnitude of flow increases which may damage channels and critical stream reaches and is estimated from ARP. The tree canopy of a forest normally provides a buffering effect to the ground surface from the effects of weather and the environment. The canopy intercepts rain and snow, and the forest vegetation uptakes water from the soil and transpires it to the atmosphere. (Streamflow increases are the result when the tree canopy is removed by logging or fire.) The increases can be caused by rapid snow melt during a rain-on-snow event and from the loss of forest transpiration. ARP addresses the impacts of logging on increased streamflow generated from rain-on-snow events.

Average increase of flow for streams affected by the burn were estimated using data from the H. J. Andrews Experimental Forest of the Willamette National Forest (Harr 1976), shown in Figure B-1. The relationship between regeneration cut (clearcut) and the percentage increase in average streamflow is shown in Figure B-2. For the purposes of comparing clearcut data from Harr (1976) with the analysis area ARP data, ARP for a subdrainage was equated to clearcut percentage given by Harr (1976).

Watershed	Code	Size Hectacre	Cut Percent	Treatment	Average Yield % Increase
Alsea Needle branch	AL-1	71 /	82	CC-R 1/	27
Alsea Deer Creek	Al-3	303	25	PC-R	5
H.J. Andrews	HJA-1	96	100	CC	34
H.J. Andrews	HJA-3	101	33	PC-R	17
Fox Creek	FC-1	59	25	PC	NC 2/
Fox Creek	FC-3	71	25	PC	NC
Coyote Creek	CC-1	6	30	SW-R	NC
Coyote Creek	CC-2	68	30	PC-R	24
Coyote Creek	CC-3	50	100	CC	70

1/ CC= Clearcut, R=Roads, PC=patch cut, SW=shelterwood
2/ NC=No Change

Figure B-1 Summary of increases in annual streamflow in western Oregon (from Harr 1976)

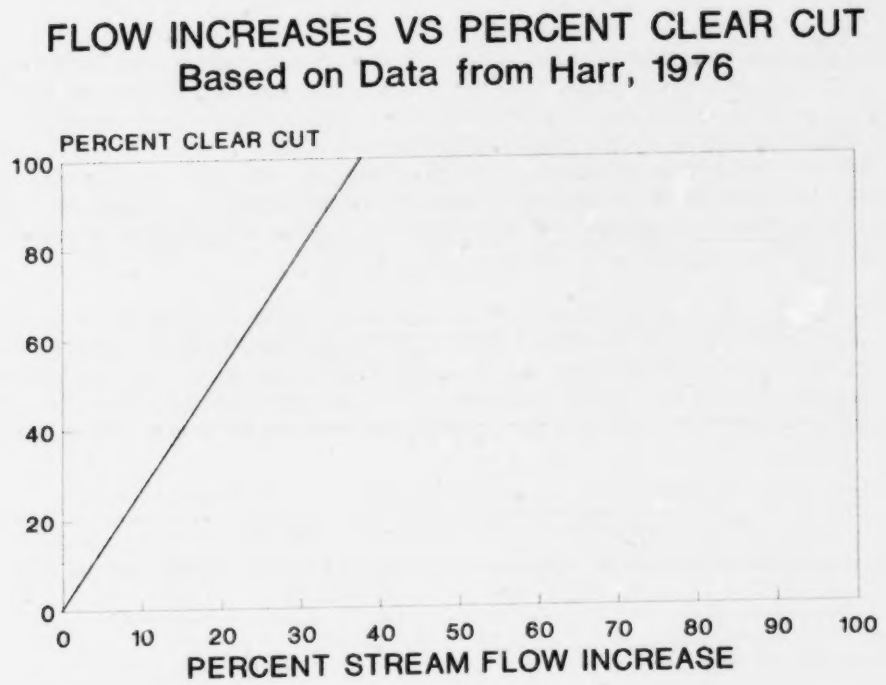


Figure B-2 The relationship between clearcut and increases in average streamflow is based on studies of harvest and streamflow at H. J. Andrews Experimental Forest (Harr 1976)

Streamflow data for Hills Creek was determined from the Hills Creek monitoring gauge established by the United States Geological Survey and U.S. Army Corps of Engineers in 1958. Streamflow for other small tributaries was derived from extrapolations of the Hills Creek data to the tributaries and was proportional to their drainage area. The average flow of Hills Creek (for August during the period-of-record) was 32 cubic feet per second (CFS). The drainage area of Hills Creek above the gauge is 52.7 square miles, giving 0.6 CFS/square mile following area extrapolation methods of Friday and Miller (1984). Figure B-3 is a summary of data from the project area drainages, and was used to evaluate drainages in the analysis.

Subdrainage	Acres	Total Stream Miles	Stream Density	Pre-Fire Streamflow (CFS)	Post-Fire Streamflow (CFS)
121AB Bull Cr.	268	11.7	4.0	1.80	1.97
121AC Modoc Cr.	1856	2.9	4.1	0.40	0.46
122BB Crabapple Cr.	665	2.4	2.3	0.63	0.68
122BD Gate Cr.	423	1.2	1.9	0.40	0.45
122BF Shady Cr.	618	3.1	3.2	0.59	0.59
122CB Skipper Cr.	418	2.1	3.2	0.35	0.37
122CD Mike Cr.	1389	7.4	3.4	1.32	1.42
122PA Tufti Cr.	992	6.9	4.5	0.94	1.04
122QD	484	1.8	2.4	0.46	0.47
122RB Landes Cr.	1525	6.5	2.7	1.45	1.51

Figure B-3 Summary of stream and subdrainage data in the Shady Beach area. Streamflow data predicted from drainage area and ARP changes

Peak Flows

Increases in peak flows due to fire effects and salvage logging are especially important because of the potential for damage to stream channels, headwalls, roads, and because of the increased sediment yields they generate. Average water-yield increases based on data from Harr (1976) were used to estimate increases in peak flows. However, peak flows generated from rain-on-snow events could be much larger, up to 50 percent more, than this average (Christner 1981; Harr 1986).

In order to evaluate peak-flow increases, a peak-flow, recurrence-interval graph was constructed using annual peak flows (1-day duration) from 1959 to 1981 (Figure B-4). This recurrence-interval graph was used to estimate the increase in peak flows by multiplying the peak flow of a given flood by the estimated percent increase that would result from the various alternatives. A maximum peak-flow increase for the burn area of 50 percent, based on data from Harr, (1986) was used to evaluate the increase for Hills Creek. An approximate 8 percent increase in Hills Creek would result from a 50-percent increase for burn-area streams. For example, a 10-year, pre-fire flood of 3,050 CFS would become a post-fire flood of 3,294 CFS, if a 50-percent increase were to occur from burn-area streams.

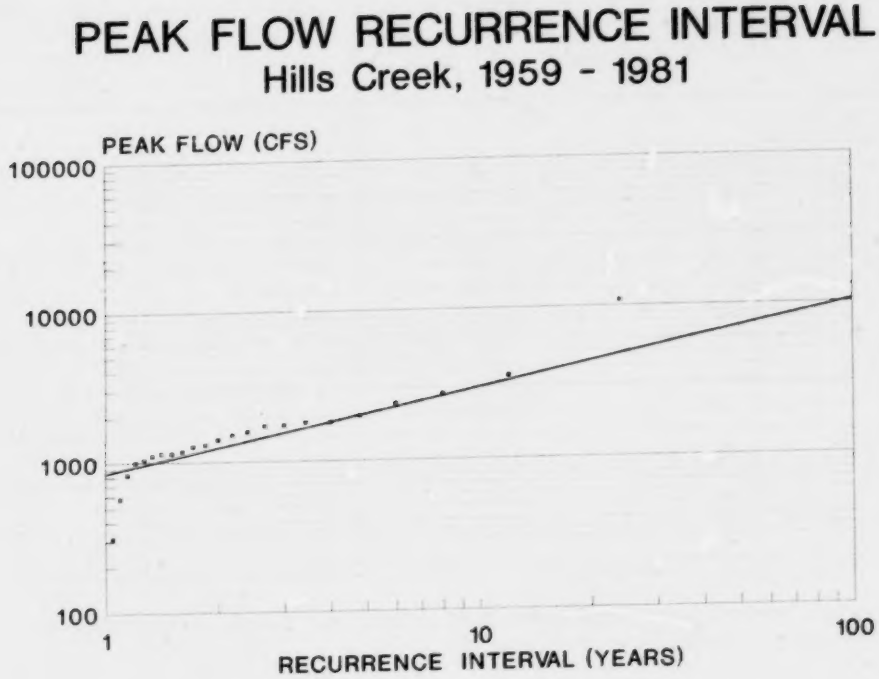


Figure B-4 Recurrence interval graph for Hills Creek for the period 1959 to 1981

Verification of predicted flows in Figure B-3 was made by comparing them with instantaneous streamflow data for Landes Creek. Instantaneous streamflow is a short time span measurement of streamflow. Actual flows in Landes Creek were 2.61 CFS on 8/9/76, 2.61 CFS on 8/16/76, 2.61 CFS on 8/24/77, and 1.13 CFS on 7/28/77 (Rigdon Ranger District records). The September Landes flow data compare well with a predicted mean flow of 2.3 CFS, predicted from the area extrapolation. This is significant because it shows how our predicted flows compare with earlier pre-fire data. Additionally, the Rigdon Ranger District has established monitoring stations as of October-November, 1988 on the following streams in the project area: lower Hills Creek, upper Hills Creek, Bull Creek, Tufti Creek, Gate Creek, lower Mike Creek, upper Mike Creek, Modoc Creek, Big Willow Creek, Juniper Creek, lower Landes Creek, east Landes Creek, and west Landes Creek. These will provide checks on our predictions and insure State water quality standards are being met.

EROSION AND SEDIMENT

Erosion and sediment were analyzed to evaluate turbidity, sediment yield to Hills Creek Reservoir, and the impact on fish habitats of increases in sediment yield and turbidity. A sediment rating curve was generated from flow rate and suspended sediment data from Hills Creek and Landes Creek (Figure B-5). An Erosion Index was used to evaluate the potential of eroded material reaching the stream channel. The actual delivery of material to the stream was not quantitatively modeled because of the large uncertainties in delivery and routing models. The Erosion Index was largely based on the total soil erosion. Total soil erosion was calculated by the project team's soil scientists and is described in the Combined Soil Erosion Process Paper in the Shady Beach analysis file.

The Index uses the following equation and was applied to each subdrainage in the project area.

Erosion Index =
0.497 + 0.083 (%Slope x Drainage Density x Runoff Curve (RCN)#) x (Total Erosion cy/yr)

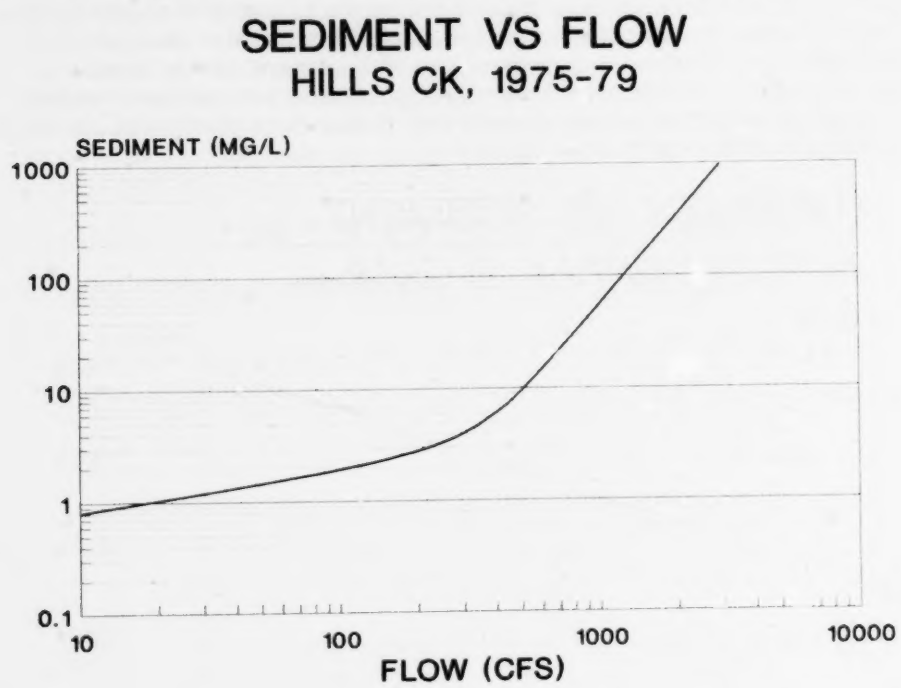


Figure B-5 Sediment rating curve for Hills Creek and tributaries. The curve is based on data from Hills Creek and Landes Creek. Data was collected 1975-79.

The runoff curve number (RCN) was developed for western Oregon Douglas-fir forests and incorporates percent bare ground and hydrologic soil group (Legard and Meyer, 1973). Percent bare ground was determined from fire intensity because it is directly related to fire consumption of the duff layer. Slope is the average slope of the subdrainage. Erosion caused by roads was taken into account, however, sediment routing due to roads was not taken into consideration because of the difficulty in estimating the amount of sediment delivered to streams from roads and road ditches (EPA 1980).

TURBIDITY

Turbidity is a measure of the cloudiness or opaqueness of water and increases with suspended sediment concentration, but at a slower rate. Suspended sediment refers to silt and clay-sized particles and turbidity refers to the property of this sediment to scatter light and make the water cloudy. The relationship between suspended sediment and turbidity for the project area was established from data for Hills Creek and Landes Creek (Figure B-6). The following equation was derived from the relationship shown in Figure B-6.

$$\text{Turbidity} = 2.5(\text{Suspended Sediment})^{1/2}$$

Turbidity and suspended sediment levels for low-flow, summertime conditions were not considered because the relationship between suspended sediment and turbidity during low-flow conditions was considered suspect. Low-flow turbidity increases were not estimated but were thought to be substantially less than high-flow increases. Monitoring data collected during the winter of 1989 for post-fire conditions show turbidity increases in streams draining the burn area of roughly 10 times pre-fire levels. Erosion Index values in cy/ac/yr were used as an approximation of the sediment delivered to Hills Creek Reservoir. Gross assumptions were with sediment delivery to streams and sediment routed to Hills Creek Reservoir. These assumptions were not accurate enough to delivery and rout sediment at the subdrainage analysis level. Suspended sediment was calculated into turbidity following the relationship outlined above.

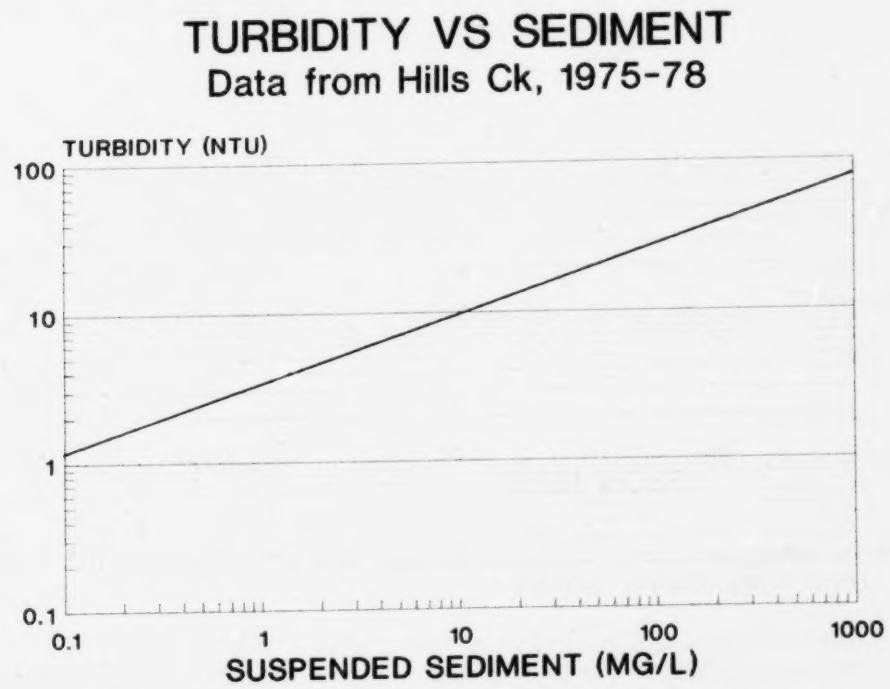


Figure B-6 The relationship between suspended sediment and turbidity is based on data from Hills Creek and Landes Creek. Data collection dates are 1975-79.

Turbidity Within The Reservoir

Tributary turbidity occurs as pulses during peak flows and are followed by rapid recovery. These waters enter the reservoir as turbidity currents (density currents) and increase the reservoir turbidity from mid-depth to the bottom (Scheidt and Nichols, 1976)). The coarser sediments settle quickly, leaving only the colloids in suspension for long periods of time (Figure B-7).

During summer months when conditions are relatively stable, the sediment-related turbidity of the pool is low in the upper zone, from the water surface down to the 1,450 foot elevation (this is approximately 1,450 feet on the turbidity profile of Figure B-7). This nonturbid water enters the reservoir from spring flows. Spring flows from snow melt are commonly much less turbid than winter storm runoffs. Below the 1,450 foot elevation, the summer pool exhibits a strong turbidity gradient that extends to the reservoir floor (Figure B-7). The Penstock (power) release is drawn from this level. Hence, the power releases remain turbid throughout the summer.

For post-fire conditions, the turbidity increases of streams draining the burn area and of Hills Creek were estimated directly from the suspended-sediment turbidity relationship established in Figure B-6. Primary sources of suspended sediment for Hills Creek Reservoir are Hills Creek and the Middle Fork of the Willamette River. Secondary sources are Packard Creek, Coffee Pot Creek, and Larison Creek. Youngberg and others (1971) estimate that Hills Creek contributes 12 percent of the turbidity of Hills Creek Reservoir. This estimate is largely based on the water volume contribution of Hills Creek compared to the entire Hills Creek Reservoir watershed. It was predicted that the stretches along Hills Creek with gradients less than 2 percent could be sites of sediment accumulation during periods of high-sediment movement (see Figure B-8). The potential for sediment accumulation in Hills Creek decreases the sediment routing to the reservoir.

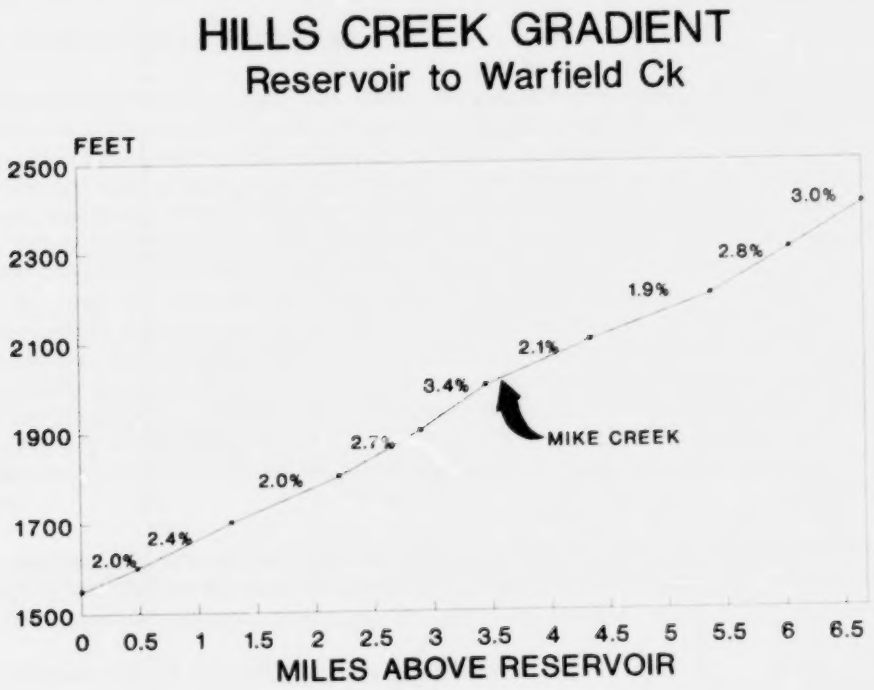


Figure B-7 Turbidity profiles for Hills Creek Reservoir, 27 May through 3 July 1971 (Youngberg and others, 1971)

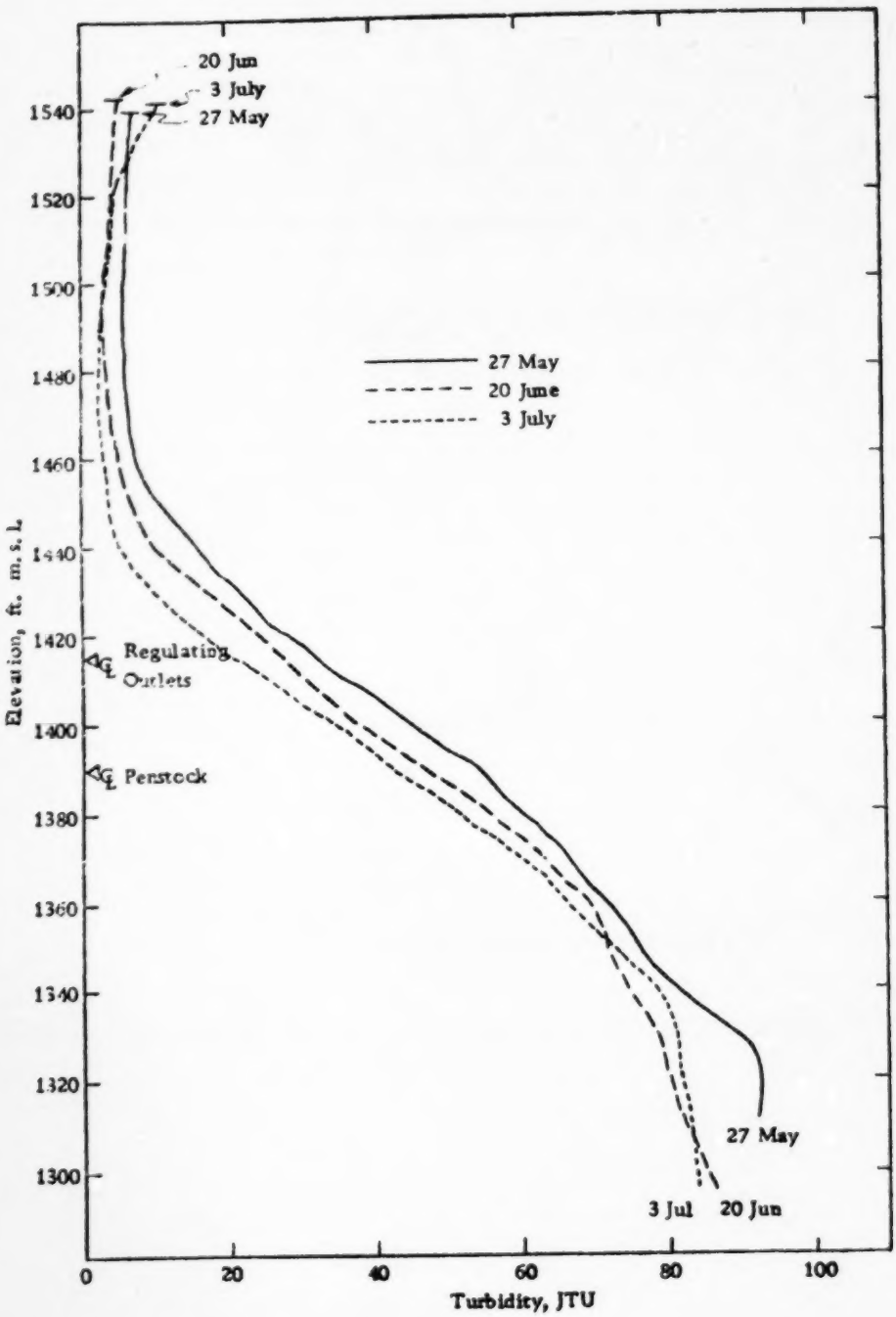


Figure B-8 Stream gradient (displayed by percent) of Hills Creek from Hills Creek Reservoir to Warfield Creek

The estimation of the turbidity increase of Hills Creek resulting from burn effects was based on a comparison of the turbidity of the lower, turbid zone of Hills Creek Reservoir (Youngberg and others, 1971) with turbidity values of post-fire peak flows of Hills Creek (November 1988, Rigdon District records). In order to compare these turbidities, Jackson turbidity unit (JTE) turbidity data from Hills Creek Reservoir was converted to suspended solid data using Figure B-1, Appendix B of Youngberg and others (1971). Similarly, nephlometric turbidity unit (NTU) turbidity data and the corresponding suspended sediment data from post-fire peak flows on Hills Creek were then compared to the Hills Creek Reservoir data. This comparison revealed that the turbidity and suspended sediment values were of very similar levels. Considering the small volume percent that the contribution of Hills Creek has on the reservoir, the high turbidity of the lower zone in the reservoir is estimated to mask the turbidity increase caused by fire effects.

LIFE OF HILLS CREEK RESERVOIR

The life of Hills Creek Reservoir was analyzed by determining how much sediment yield would be delivered to the reservoir from the burn area. During the design of the Hills Creek Reservoir, sediment yields were estimated in order to predict the life of the reservoir. The estimated sediment yield of the drainage area affecting the reservoir is 100 acre feet/year or 161,333 cubic yards/year. This amount was stated to be insignificant when compared to the dead storage volume of 107,000 acre feet or 1,550,000,000 cubic yards/year (U.S. Army Corps of Engineers 1988). The Proposed Forest Plan/DEIS estimates 71,262 cubic yards of erosion/year, however, this figure is not sediment yield but is erosion potential and is 44 percent of 161,333 cubic yards. Only a fraction of the erosion potential would actually be delivered to the reservoir. Sediment delivery to streams resulting from just the fire was estimated to be 779 cubic yards/year (see Figure II-1), most of which will settle in the reservoir. Erosion Index values for project area subdrainages were used as a rough estimate of sediment delivered to streams. Half of the sediment delivered to Hills Creek was assumed to reach Hills Creek Reservoir. This amount of sediment was **not** considered to be a significant impact on the life of Hills Creek Reservoir because these high-sediment yields will last only a few years.

The sediment-trapping efficiency of the reservoir is 96 percent and therefore the downstream affects of sediment in the reservoir are probably insignificant (Youngberg and others, 1971). Only a small volume will escape, mostly the very fine-grain material, which are the turbid outflows.

TEMPERATURE OF PROJECT AREA STREAMS

The temperatures of Class II and III streams in the project area were analyzed to determine the magnitude of temperature increases caused by the fire. Increased stream temperatures are known to be detrimental to fish production, particularly in southwest Oregon (Lantz 1971). Brown (1970, 1972) has established that direct solar radiation impinging on the stream surface is the primary cause of stream heating and that largely accounts for rises in summertime temperatures of streams. Management activities affect stream temperatures by removing vegetative shade or by establishing vegetation that provides shade. A comparison of the differences between pre-fire, post-fire, and post-logging was made to determine if salvage logging will have a significant effect on the temperature of the streams.

Baseline temperature data is available for Hills Creek. The United States Geological Survey (USGS) collected stream temperature data for the period of record for the gauge for about 20 years (Friday and Miller, 1984). The U.S. Army Corps of Engineers has collected temperature data at the USGS gauging station site for about 5 years after the USGS discontinued the gauge (U.S. Army Corps of Engineers 1988). Temperature data was collected in Landes Creek for about 3 years in the late 1970's. These data indicate that the Hills Creek average August temperature is 63 degrees F with some temperatures reaching 70 degrees F. Historically, 58 degrees F is exceeded all through

the summer months of June through September for Hills Creek. This temperature has also been exceeded in many of the smaller streams over the summer months. Temperatures exceeding 58 degrees F occur from around the last week of June through all of September. Landes Creek, on the other hand, has a maximum temperature of about 50 degrees F, although a few days did reach 57 degrees F. Prior to the fire, Landes Creek, and probably all of the other shaded tributaries, have had a cooling effect during the summer on Hills Creek.

Stream temperatures of Hills Creek during August were examined, over time, to determine whether a temperature change had occurred. A heating degree day was determined by subtracting the standard (58 degrees F) from the maximum temperature for the day. The heating degree days for the period of interest (the last week of June, all of July, August, and September) were added together to obtain an index of the amount of heat in the stream. A trend in the heat content of the stream was then derived by plotting index records over the years of record (Figure III-4). This showed the effect of activities within the watershed on stream temperatures and provided a baseline of the pre-fire conditions in the stream.

A temperature increase, over time, was observed in the Hills Creek data (Figure B-9). The maximum temperatures for August that were above 58 degrees F show a temperature increase of about 4 degrees F for the period from 1959 to 1981 with medium correlation (r2 = .28).

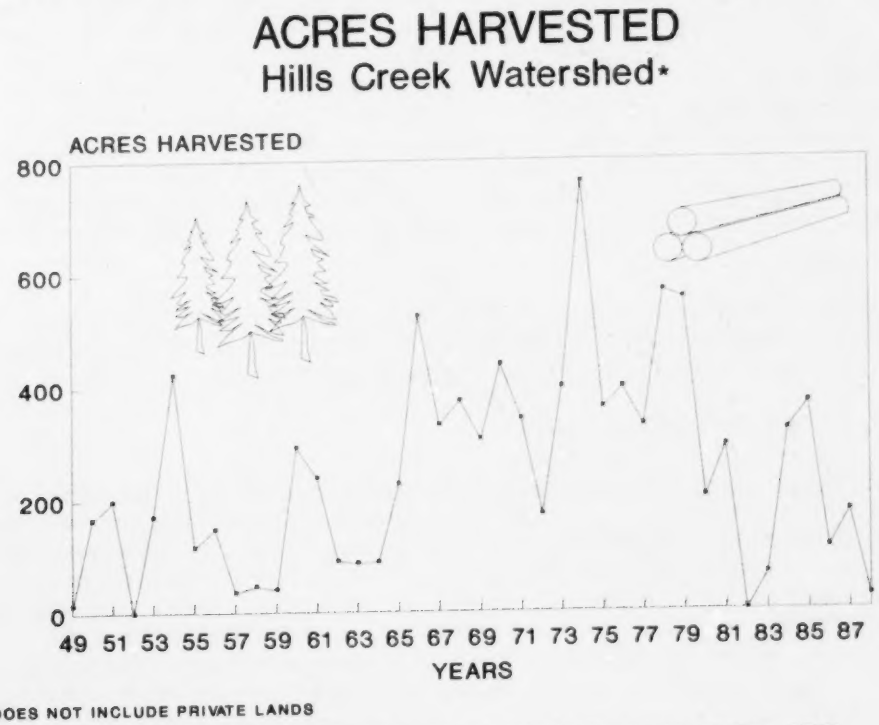


Figure B-9 - Acres harvested on Forest Service lands for the years 1949 to 1988

To further assess the effects of management activities on stream temperature, the cumulative harvest effects for the Hills Creek watershed were evaluated for the period from 1949 to 1988 from harvest data stored in the Total Resource Inventory (TRI) system (Figure B-9). A shade index, which evaluated the cumulative shade loss and shade recovery over time, was constructed from the area harvested (Figure III-7). A time function which estimates the percent shade recovery based on Summers (1983), as modified by Beschta and Taylor (1988), was applied to the yearly acres harvested in order to come up with a cumulative estimate of the percent shade on the Hills Creek watershed. The shade index shows a peak of effects between 1979 to 1981. This peak lags behind the peak harvesting of the mid- to late-1970's. The sharp drop in timber harvest, starting in 1980, corresponds to the gradual drop in the cumulative effects which begin in 1982.

During the period from the last week of June to the end of September, the removal of shade from Class IV streams will have little impact on the stream temperature. This is because Class IV streams are ephemeral and generally do not flow during the summer. However, harvest of Class IV streamways will increase the potential for mass wasting which, in turn, could destroy downstream Class III shade. (See Geology Process Paper in the Shady Beach analysis file.)

Modeling Stream Temperature Changes

1. Use of Brown's Equation

While the accounting of various energy exchanges which occur in a natural stream can become exceedingly complex, the simple model which Brown (1970) developed provides fairly accurate estimates of stream-temperature changes associated with loss of stream shade; however, this model was developed for use on short (less than 2,000 feet) segments of stream.

Its application to loss of shade in an entire basin necessitates testing against a known value. Use of the equation in this model was modified using the mixing formula suggested by Brown. Exposed, low-flow surface area by stream size was summarized for each analysis area and was used in Brown's equation with the basin discharge as the denominator. The following equations show the application of Brown's equation and its use in this model:

Equation 1

$$Td = \frac{H \times A \times 0.000267}{Q}$$

where: Td = stream temperature change
H = rate of heat input per unit area
(constant for given latitude and stream velocity)
A = total unshaded stream surface area
Q = Stream discharge, CFS

Temperature change at basin mouth:

Equation 2

$$Td = \frac{(Q1 \times T1) + (2 \times T2)}{Q1 + Q2}$$

where: Td = change in downstream temperature after mixing
Q1 = discharge of tributary 1
Q2 = discharge of tributary 2

Td1 = temperature of tributary 1
Td2 = temperature of tributary 2

Equation 3 Temperature after mixing = baseline Temperature + Td

A number of estimates and assumptions are required to use the above model in this fashion. They include:

Absorbed Solar Radiation and Travel Time - A flow velocity of 1 foot per second was assumed. In reality, this value would be highly variable depending on stream gradient, roughness, etc. However, the value only enters the calculations in the determination of the absorbed solar radiation constant, and the relationship is very flat with large differences of travel time yielding small changes in absorbed radiation constant. A value of 4.0 BTU/FT2-MIN was assumed (Brown 1970).

The streamflow in each subdrainage was estimated using the assumption that streamflow is directly proportional to drainage area. The inflow of Hills Creek was used for the subdrainages in the burn area.

The effects of bedrock, travel time from headwaters of the basin to the mouth, and ground water inflow were not determined or analyzed. These effects were assumed to be homogeneous between subdrainages.

2. Determining Unshaded Surface Area

Crown closure was used to estimate shade because the mortality layer has percentage crown closure data that can be directly converted to shade. The amount of live crown closure for each crown layer was found by subtracting one from the percent mortality and multiplying the resulting percentage by the crown closure for the same crown layer. The sum of the live crown closures for all three crown layers represented the total post-fire crown closure available for stream shading for each predicted mortality unit. Stream shade percentages were derived by integrating Solar Pathfinder data (Figure B-10), stand age, total crown closure, and shade recovery predictions based on Summers (1983), as modified from Bechta and Taylor (1988). These shade percentages for individual cells were accumulated to give a percentage shade for the entire stream length.

The unshaded stream surface area was found by subtracting one from the percent of the stream shaded and then multiplying by the total stream surface area. The total unshaded stream surface area for each subdrainage was determined by totaling the unshaded surface within each predicted mortality unit.

RIPARIAN SHADE DATA

	North Aspects			South Aspects			
% Shade Month	Burned Old-growth #1	Unburned Old-Growth #2	Burned Old-Growth #3	Unburned Old-Growth #4	Burned Old-Growth Buffer Strip #5	Burned Reprod Age -15 years #6	Unburned Reprod Age -15 years #7
June	71	82	15	100	10	13	37
July	68	82	19	96	12	15	51
Aug.	72	88	26	95	26	15	49
Sept.	85	93	34	93	25	11.5	46

Elevation	1700'	2100'	2560'	2920'	2780'	3080'	3120'
Stream Class at Location	2	2	2	3	3	3	3
Valley Side Slopes	30%	30%	6%	12%	24%	17%	17%

Figure B-10 Riparian shade data for the Shady Beach area. Data was obtained from Solar Pathfinder measurements taken in November 1988 (see Solar Pathfinder/Riparian Shade Process Paper, Shady Beach analysis file).

3. Modeling Changes in Summer Minimum Flows

The loss of evapo-transpiring vegetation in a watershed results in an increase in the amount of runoff from a basin (Harr 1976). In particular, low-flow discharge can experience dramatic percentage increases (Harr and Krygier, 1972). These increased low flows have two effects on stream temperature estimates:

1. The increased flow (Q) represents a larger, faster-moving volume of water to which the heated/exposed water has a smaller effect and,

2. The increased flow results in a somewhat wider stream and thus larger surface area of water exposed to the sun in unshaded sections of stream.

The latter effect results in an increase in the amount of heat in the system. The net effect of the two results depends on the width-to-depth ratios of the stream involved and the amount of the system exposed. If the increase in discharge associated with lost vegetation in the watershed is proportionately larger than the lost shading along the channel, the predicted stream temperatures would likely be less than if the increased flows were ignored. Post-fire stream widths were adjusted based on post-fire flow estimates (Figure B-11).

Flows for subdrainages were determined by dividing the total acres in the Hills Creek Watershed above the gauging station by the average flow of Hills Creek in August (32 CFS). The average flow per acre for the watershed was multiplied by the number of acres in each subdrainage to approximate the flow in each subdrainage. Post-fire flows were adjusted based on calculated post-fire ARP.

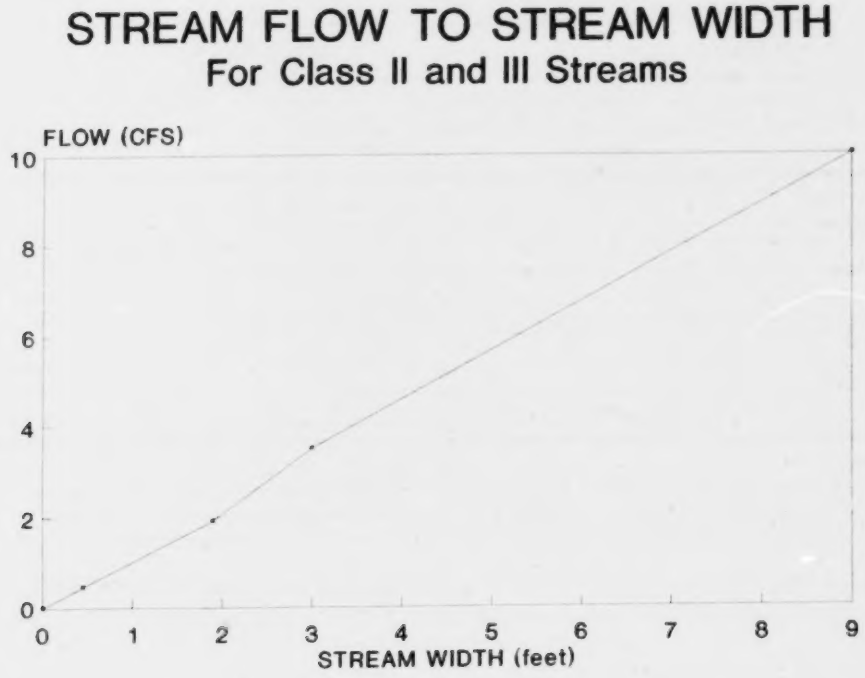


Figure B-11 The relationship between streamflow and width

4. Stream Shade Changes

Post-fire stream shading was estimated from field observations of percent crown mortality along stream lengths of Class II and III streams. This data was calibrated to field observations of post-fire shade using a Solar Pathfinder. Riparian shade locations were evaluated using the Solar Pathfinder at points in the stream that were most representative of each riparian zone. (See Shady Beach analysis files.)

Harvest-related shade loss was modeled based on the actual management objectives for each alternative. The shade loss percent for a given riparian-area, harvest-unit prescription by alternative are given in Figure B-11. For partial cut prescriptions, an additional 10 percent shade loss was assumed to allow for skyline corridors. A recommended 67-foot buffer strip on each side of the steam was recommended based on studies by Steinblums, Froehlich, and Lyons (1984).

5. Pre-fire Management Related Temperature Changes

The effects of past management on stream temperatures were calculated and incorporated into the stream-temperature model. The following outlines the sequence of steps and assumptions used in this calculation:

1. Stream miles were determined by class and size for each analysis area both inside and outside the fire.

2. The area in each analysis area inside and outside the fire was estimated.

3. Acres harvested in each analysis area were determined by year of harvest (based on TRI).

4. Shade reduction was estimated by stream class (see Figure B-10).

A pre-fire temperature for each subdrainage was calculated using stand age, Brown's equation, and limited temperature data that was collected during 1977 to 1978 in Landes Creek. Unshaded stream surface areas during 1978 were determined for all of the analyzed subdrainages. Mean August 1988 (pre-fire) temperatures for each subdrainage were calculated with Brown's equation and estimated flows and are relative to Landes Creek.

Temperature of Reservoir

The temperature of Hills Creek Reservoir was analyzed to determine what were the downstream effects of the temperature increases from the burn area, if any. Power releases at the Hills Creek Reservoir outlet are at the 1,390 feet elevation (12-foot intake with the bottom of the pipe at 1,384 feet). The temperature at this level during the month of August is 43 degrees F (Youngberg and others, 1971). This 1971 thermocline of the Hills Creek Reservoir is similar to the 1988 thermocline of Detroit Reservoir and Green Peter Reservoir (USDA Forest Service 1988e). It was concluded, therefore, that the thermocline has changed little over the past 17 years even though there appears to be a general warming trend in the inflow temperature of Hills Creeks and other western Cascade streams (Beschta and Taylor, 1988). (See Figure B-7). The warmer summer flows from tributaries override the denser colder and more turbid waters. No downstream change in temperature is expected since the outlet draws from cooler waters lower in the reservoir.

BEDLOAD SEDIMENT

Bedload sediment was addressed because of its impact on spawning (see Chapter IV, Water Quality) and its contribution to the total sediment yield. Bedload sediment production in the project area is subordinate to suspended sediment production because the geologic rock types in the Project Area weather rapidly into clay and silt-sized particles. Little sand is produced by weathering and erosion. Bedload sediment is a significant impact to fish habitat but probably not to the life of Hills Creek Reservoir. Bedload sediment yields are difficult to evaluate (Dunne and Leopold, 1978), and because of this difficulty and their subordinate nature, bedload sediment was not evaluated.

EVALUATION OF INCOMPLETE AND UNAVAILABLE INFORMATION

The water quality/fish habitat models used did not attempt to tie the effects of the different aspects together to form one index to assess the effects on the fisheries in the project area. Because of the lack of research on the cumulative effects of changes and interrelationships between the key fisheries aspects it was felt that to attempt to do so would not be appropriate. Changes in each of the most important indicators of water quality and fish habitat were assessed. The model selects key indicators of the condition of the watershed ecosystem and, using the present state of the art knowledge and field observations, attempts to predict the magnitude of change that can be expected with various alterations of the watershed and its streams. As such, the model provides an adequate level of information to allow a reasonable choice to be made among a given set of alternatives.

The ability to obtain data for such a model on a large land base is limited. While the model does evaluate stream habitat conditions as related to watershed interactions cumulatively in a drainage or subdrainage, it is not designed to predict site-specific locations of change in habitat. The model indicates watershed areas of potential concern and subdrainages which are most likely to be impacted.

Another major limitation of the model is the simplification of the variability that occurs in nature. While the model predicts the most probable mean values, significant variation can occur locally. Such factors as reburning of the area, major floods, and wind storms are outside the scope of this analysis.

Coefficients used in the model were developed to estimate actual expected values and do not represent a best or worst case scenario, though a conservative approach was taken in developing the predictive coefficients. Most of the data used in developing the model were taken from past data either gathered in or adjacent to the study area or was obtained from research conducted on areas located in close proximity to the study area. The sediment, turbidity, and fisheries habitat potential data was further refined to reflect additional data gathered since the occurrence of the Shady Beach Fire. As such, a high confidence level is assumed that the model is able to accurately predict water quality and fish habitat condition and changes in the drainages and subdrainages in the study area. This high confidence level has been confirmed by comparing predicted values against actual data gathered since the fire. In comparison of predicted with measured values, it appears that the model tends to slightly over predict suspended sediment and turbidity.

The model coefficient with the lowest reliability is the prediction of the efficiency of mitigation on sediment delivery. While considerable research has been conducted to establish the effects of mitigation, the results have shown a wide range of effects. Similarities between studies seem to be masked by site specific attributes such as topography, geology, and climatic differences. The mitigation efficiency coefficients used in the model were arrived at using current research and the professional opinions of team specialists (soil science, hydrology, geology, and geotechnical engineering) based on field observations in the study area or areas similar to the study area.

The occurrence of a major flood within the next 10 years would have the greatest negative impact on the drainage, resulting in far greater impacts than the model would indicate. However the probability of such an occurrence is extremely low. For example, the probability of a 100-year return interval event occurring in a 10-year time period is 10 percent.

If such a flood were to occur, the impacts on the fisheries would likely be catastrophic, with a possible complete loss of the fishery for some period of time. Once stream conditions began to recover, the fish species could be re-introduced into the system with the potential to re-establish over a 10 to 20 year period providing stream conditions recovered to suitable habitat. Any of the action alternatives would increase the potential magnitude of the impacts experienced under such a scenario, but the ability to discern the effects of management actions from the effects of such a flood would be difficult. The primary impacts would be related to increased flows caused by removal of forest cover and sediment production associated with road construction.

LARGE WOODY DEBRIS (LWD)
By Dede Steele

LWD was addressed because of its importance to streams in channel stabilization. LWD is also vital to fisheries, the beneficial use identified for water resources. LWD is important in water aeration which improves dissolved oxygen concentrations and, in turn, is important to fish. LWD also provides nutrients into the stream systems which supplies the aquatic and riparian ecosystem food chains. LWD is important in creating structural diversity within the stream system, which is an important feature in aquatic and riparian habitats. LWD in streams creates pools where fish can live and find calm water for resting and cover for hiding.

LWD available for input to the streams is affected by past management practices, by fire history, and the Shady Beach fire. Where past timber harvest did not provide adequate stream buffers, the potential for input of LWD is limited or eliminated. Where past timber harvest provided stream buffers, the buffer left after harvest and fuel treatments range in effectiveness from no potential to high potential for LWD input. Where the fire burned through timber along streams or through stream buffers left after timber harvest, the potential for long-term input of LWD was reduced where fire intensities were high. In these areas the potential for input of LWD is short-term, as the fire killed trees fall. Long-term input of LWD will be eliminated until new stands become established and mature.

Past management activity maps were overlaid with stream class maps to serve as riparian impacts base maps. Data from field inventories of existing stream buffers in harvest areas was used to identify areas of moderate long-term potential and areas with no potential for LWD input. Remaining areas were assumed to be in high long-term potential. This information was used to estimate the pre-fire length of streams in each of the three LWD potential classes (high long-term, moderate long-term, no LWD).

Outright mortality maps were then superimposed over the maps used for the pre-fire evaluation to identify areas reduced to post-fire, short-term potential. This information was used to estimate the post-fire No Action length of streams in each of the four LWD potential classes (high long-term, moderate long-term, short-term, no LWD).

For analysis of alternatives, harvest unit maps were superimposed over the maps used for the post-fire No Action evaluation. Harvest units along or across Class I, II, or III streams were considered to reduce high long-term potential to moderate long-term potential in Alternatives C, D, and F, or to short-term potential in Alternative B. Harvest units along or across Class IV streams were considered to reduce high or moderate long-term potential to no LWD potential for all alternatives. Exceptions to this were where streams were in short-term potential condition due to fire impacts. In such cases, Class I, II, and III streams were considered to remain in short-term potential, whereas Class IV streams were considered to be reduced from short-term potential to no LWD potential.

The percentages displayed in Figure B-12 are based on the percentage of the length of streams in each stream class that are in each LWD potential class. A summary of percentage of the stream length (combined for all stream classes) is displayed in Chapter IV.

LARGE WOODY DEBRIS
WATER QUALITY/FISHERIES
PERCENTS BY INDIVIDUAL ALTERNATIVE

STREAM CLASS:		I						II						III						IV					
		P	B	C	D	F	E	P	B	C	D	F	E	P	B	C	D	F	E	P	B	C	D	F	E
21A	LT LWD High	0	0	0	0	0	0	89	33	33	33	83	83	93	0	0	0	86	86	70	17	23	14	54	56
	LT LWD Moderate	0	0	0	0	0	0	11	11	61	61	11	11	0	86	86	86	0	0	4	4	15	43	15	2
	ST LWD only		0	0	0	0	0		56	6	6	2	6		7	7	7	7	7		15	0	0	10	16
	No LWD	0	0	0	0	0	0	0	0	0	0	4	0	7	7	7	7	7	7	26	64	62	42	21	26
21B	NO CHANGE																								
	LT LWD High	0	0	0	0	0	0	61	61	61	61	61	61	50	50	50	50	50	50	35	35	35	35	35	35
	LT LWD Moderate	0	0	0	0	0	0	15	15	15	15	15	15	0	0	0	0	0	0	0	0	0	0	0	0
	ST LWD only		0	0	0	0	0		0	0	0	0	0		0	0	0	0	0		0	0	0	0	0
	No LWD	0	0	0	0	0	0	24	24	24	24	24	24	50	50	50	50	50	50	65	65	65	65	65	65
22B	LT LWD High	70	5	5	5	70	70	90	0	0	0	60	67	68	28	28	28	30	56	88	0	0	0	20	44
	LT LWD Moderate	30	30	95	95	30	30	0	20	20	20	0	0	14	12	32	32	30	4	0	0	0	7	0	0
	ST LWD only		65	0	0	0	0		70	70	70	36	33		33	22	14	20	22		7	26	24	31	44
	No LWD	0	0	0	0	0	0	10	10	10	10	4	0	18	27	18	26	20	18	12	93	74	69	49	12
22C	LT LWD High	83	66	66	66	83	83	54	8	8	8	8	8	36	21	21	21	29	29	54	24	24	22	22	41
	LT LWD Moderate	0	17	17	17	0	0	0	0	0	0	0	0	0	7	7	7	0	0	20	0	2	4	20	0
	ST LWD only		0	0	0	0	0		36	46	36	36	36		7	4	7	7	7		0	0	0	0	13
	No LWD	17	17	17	17	17	17	46	36	46	36	36	36	64	65	68	65	64	64	46	76	74	74	58	46
22D	NO CHANGE																								
	LT LWD High	0	0	0	0	0	0	55	55	55	55	55	55	41	41	41	41	41	41	61	61	61	61	61	61
	LT LWD Moderate	0	0	0	0	0	0	0	0	0	0	0	0	6	6	6	6	6	6	0	0	0	0	0	0
	ST LWD only		0	0	0	0	0		0	0	0	0	0		0	0	0	0	0		0	0	0	0	0
	No LWD	0	0	0	0	0	0	45	45	45	45	45	45	53	53	53	53	53	53	39	39	39	39	39	39
22P	LT LWD High	92	44	44	44	91	97	75	0	0	0	0	25	44	6	6	6	6	44	28	0	0	0	0	0
	LT LWD Moderate	0	53	53	53	6	0	25	25	25	25	25	0	12	12	38	38	38	0	0	0	0	0	0	0
	ST LWD only		0	0	0	0	0		75	75	75	75	75		38	12	12	12	12		0	0	0	18	28
	No LWD	8	3	3	3	3	3	0	0	0	0	0	0	44	44	44	44	44	44	72	100	100	100		
																							82	72	
22Q	LT LWD High	42	8	8	8	42	42	67	67	67	67	67	67	50	0	0	0	50	50	47	13	13	7	27	40
	LT LWD Moderate	58	54	92	92	58	58	0	0	0	0	0	0	0	50	50	50	0	0	0	13	13	33	13	0
	ST LWD only		38	0	0	0	0		0	0	0	0	0		0	0	0	0	0		7	7	6	7	7
	No LWD	0	0	0	0	0	0	33	33	33	33	33	33	50	50	50	50	50	50	53	67	67	54	53	53
22R	LT LWD High	74	69	69	69	74	74	29	29	29	29	29	29	40	38	38	38	41	41	49	3	3	3	29	0
	LT LWD Moderate	0	5	5	5	0	0	14	14	14	14	14	14	16	12	12	12	9	9	0	34	34	34	11	40
	ST LWD only		0	0	0	0	0		0	0	0	0	0		6	6	6	6	6		9	9	9	9	9
	No LWD	26	26	26	26	26	26	57	57	57	57	57	57	44	44	44	44	44	44	51	54	54	54	51	51

P = Pre-Fire

Figure B-12

SILVICULTURE

SHADY BEACH FIRE RECOVERY PROJECT
OAKRIDGE, OREGON
By
Paul W. Survis, Silviculturist

ANALYSIS PROCESS

The scope of silvicultural analysis within the Shady Beach fire area was to predict and quantify individual tree mortality and assess the impacts upon stand dynamics and development.

1:12000 aerial photographs displaying the extent of the fire were provided two weeks following the control of the fire. Stands with 100 percent outright mortality, as evidenced by total needle consumption, were delineated on the photos and then transcribed to registered mylars overlayed on resource orthoquads. The location of these stands, in conjunction with the daily fire-progression map, provided the basis for the prioritization of areas to inventory and predict future mortality (Baumann 1988). The fire-progression map served as an invaluable key in assessing potential mortality. Over a wide range of fire conditions, duration of heat was more significant in causing mortality than was initial fire intensity (Ryan and Reinhardt, 1988). Field indicators of varying fire conditions which influenced mortality included:

1. Rate of spread as influenced by slope, aspect, horizontal, and vertical-fuel continuity, topography, and windspeed.

2. Type of spread: backing fire versus a head fire.
   Individual tree sampling results were expanded to larger area subjected to similar fire conditions.

INDIVIDUAL TREE MORTALITY PREDICTORS

The assessment of individual tree mortality was determined by the interaction of three components: degree of cambial damage, extent of crown scorch, and percent of root damage.

CAMBIAL DAMAGE

Physiology

The living portion of the tree stem consists of a cylinder containing the conductive vascular tissues on the inside and the protective, outer-bark layers. This cylinder is composed mainly of the wood (xylem) toward the inside and the inner bark (phloem) toward the outside, with a vascular cambium layer separating the two. Growth in diameter is due largely to the activities of the vascular cambium.

Conductive Vascular Tissues

Xylem: The principal strengthening and water-conducting tissue of the stems, roots, and leaves of vascular plants. It is characterized by the woody portion of vascular tissue.

Phloem: The inner bark. The principle tissue involved in the distribution of complex carbohydrates.

Protective Outer Bark Layers

Young stems of trees are protected from desiccation and to some extent from mechanical injury, by the epidermis (analogous to our skin). In the majority of woody plants, no provision exists for the increase in the diameter of the epidermis as the stem enlarges in girth due to the activity of the vascular cambium. Therefore, the tree develops another cambial layer, the cork cambium, in order to provide "elastic protection" as the tree increases in diameter. Thus, the bark consists of living inner-bark tissue and outer dead bark.

Cambial damage

Fire can kill portions of the cambium by direct flame contact with the bole, by radiation from nearby areas of fire and by extended smoldering of duff around the base of the tree. The duration of such heating and the thickness of the bark are the main factors influencing the extent of cambium kill (Ryan 1982). Heat sufficient to kill the cambium also kills adjacent phloem tissues thereby causing disruption of "foodstuff" translocation. See Figure C-1, Inner Living Bark. Excessive partial girdling can kill a tree. Dead cambium was identified by the following distinguishable characteristics:

> Living cambium: Healthy cambium will be nearly white and usually moist and slippery to the touch. The inner bark will not easily separate from the woody tissue.
>
> Dead cambium: Dead cambium is dry and discolored (usually brown to black). Cambial cells lose plasticity and the inner bark separates readily from the wood. Dead tissue may also have a sour/fermented smell.

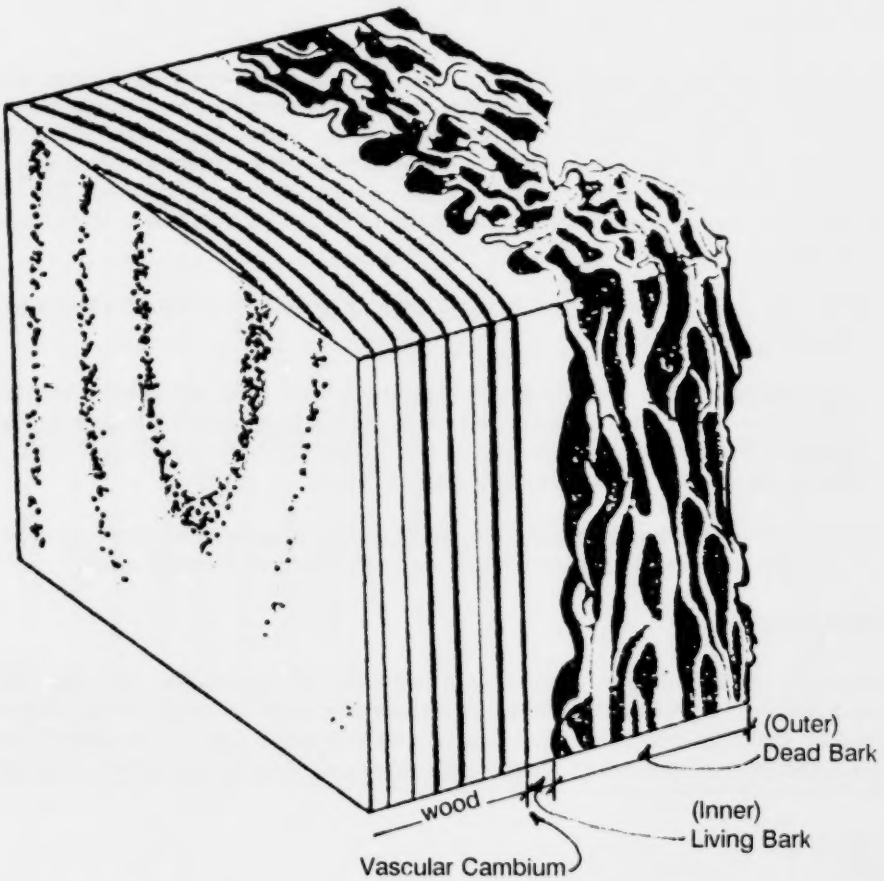
SAMPLING TECHNIQUES

As alluded to previously, duration of heat was more significant in causing mortality than initial fire intensity. Therefore, the continuity and size class of fuel loadings in conjunction with topography greatly influenced fire-duration and associated mortality.

The duration and intensity of fire varies around a bole. The lee or uphill side of the bole receives more heat than the windward or downhill side due to the "chimney" effect of fire. In addition, uphill damage may be greater than downhill because of fuel that normally accumulates on the uphill side of the bole. Given this phenomenon, cambial sampling was initiated at diameter at breast height (DBH) on the lee side of the bole. If the cambium was dead in this location, more samples were taken in the remaining three quadrants of the stem circumference. Wagener (1961) observed that trees with severe cambial damage were poor candidates for survival. He defined cambial damage as severe if more than one-quarter of the circumference was girdled. Ryan (1988) confirmed this percentage of girdling as severe damage if root damage also occurred. If there was no associated root damage, Ryan proposed a threshold of 50 percent circumference damage as severe damage leading to tree mortality.

In evaluating fire damage on a stand basis, it was impractical to examine a sufficient number of individual trees to provide a statistically valid sample due to time constraints. Therefore, field crews established mental correlations between degree of cambial damage and such factors as fire conditions, tree species and size, extent and appearance of bark characteristics (i.e., whether char extended into bottoms of furrows, how deep or fluffy the char was, and how much the original furrow/ridge profile had been smoothed by bark consumption), and the apparent depth of burn around the tree. In each area of differing fire conditions, a hand axe was used to quantify cambium damage, often at first, and regularly thereafter to maintain a properly calibrated eye.

Douglas-fir



Wood: Xylem
(Inner) Living Bark: Phloem, Cork Cambium
(Outer) Dead Bark: Dead Phloem
Vascular Cambium: Growing Layer between the Xylem and Phloem

Figure C-1

ROOT DAMAGE

In addition to cambium damage on the bole, root cambial damage also affected survival. Douglas-fir frequently has major lateral roots at or near the boundary between the organic and mineral soil. This occurrence was especially prevalent in the fire area given the widespread shallow, gravelly soils. The depth in the soil to which roots are killed depends mainly upon the amount of duff consumed and the soil moisture content at the time of the burn (Shearer 1975). Soil moisture conditions were extremely low at the time of fire ignition. The area had experienced drought summer conditions for the fifth consecutive year. Heavy damage, where 75 percent or more of the major surface roots were killed or severely injured, significantly reduced the probability of survival for all sizes of trees (McConkey and Gedney, 1951; Ryan, 1988).

CROWN SCORCH

Percent crown scorch, as a component of mortality prediction, will not be discussed in depth. Crown damage from fire can occur from outright needle consumption or from rising hot air and gasses from flames below. However, fire behavior on the Shady Beach fire was generally characterized by slow-burning ground fires with low-flame lengths. Therefore, there was little crown scorch in areas other than in stands where 100 percent crown scorch occurred. The fire behavior approximated the rates of spread and burning patterns of fuel models 8 and 10 in areas other that did not have outright mortality (Baumann 1988).

> **Fuel Model 8**: Characterized by slow-burning ground fires with low-flame lengths (approximately 1 foot).
>
> **Fuel Model 10**: Fire burns in the surface and ground fuels with greater fire intensity than fuel model 8. Dead-down fuels include greater quantities of 3-inch or larger limbwood resulting from over maturity or natural events that create a large load of dead material on the forest floor. Flame lengths approach 5 feet.

Predicted mortality on the Shady Beach fire was a function of cambial and root damage. Percent crown scorch was incidental in stands outside of the 100 percent mortality areas.

DATA COLLECTION

Data collection was performed by a silvicultural field crew utilizing the field sampling techniques previously mentioned. Individual tree and stand information was recorded on the sample field data collection form included (see Figure C-2). Crews delineated stands with differing post-fire mortality characteristics on the field photos and transcribed them to registered orthophotos.

EXISTING STAND INFO

PHOTO NO _____

STAND NO. (M.O.M) _____

ASPECT _____

SOILS _____ DUFF CLASS (1-3)

SLOPE _____

STAND CONDITION

PRE FIRE | POST FIRE

POST FIRE: PREDICTED DEAD COMPONENT | RESIDUAL GREEN

2 YEAR POTEN. DEAD

BARK BEETLE BROOD AREAS . WIND THROW / ROOT ROTS

WINDTHROW THIS WINTER GREEN TPA	SCORCH HT (FT.)	PITCH DRUID IN SCORCH Y	PITCH DRUID IN SCORCH N	SHADED Y	SHADED N	EVIDENCE OF ROOT ROT POCKETS Y	EVIDENCE OF ROOT ROT POCKETS N

PLANTABILITY / COMMENTS

- STOCK TYPE (BARE ROOT, S/R RATIO, CONTAINER...)
- STOCK SPP.
- RAVEL POTENTIAL
- SHADE CARD
- ANIMAL CONTROL
- VEGETATION COMPETITION

CANOPY & MERCHANTABLE — DOM./CODOM.

	PRE FIRE	POST FIRE: PREDICTED DEAD COMPONENT	POST FIRE: RESIDUAL GREEN
SPECIES COMPOSITION (%)			
% STOCKING [— 10-40%, ≡ 40-70%, ≡ 70-100%]			
SIZE CLASS (DBH RANGE)			
AGE/VIGOR			
BASAL AREA / ACRE			
VOLUME / ACRE			
NORMAL B.A. / ACRE			

CANOPY & MERCHANTABLE — INTERMED./SUPPRES

	PRE FIRE	POST FIRE: PREDICTED DEAD COMPONENT	POST FIRE: RESIDUAL GREEN
SPECIES COMPOSITION			
% STOCKING [— 10-40%, ≡ 40-70%, ≡ 70-100%]			
SIZE CLASS (DBH RANGE)			
AGE/VIGOR			
BASAL AREA/ACRE			
VOLUME/ACRE			
NORMAL B.A./ACRE			

UNDERSTORY — SEEDLINGS/SAPLINGS

	PRE FIRE	POST FIRE: PREDICTED DEAD COMPONENT	POST FIRE: RESIDUAL GREEN
SPECIES COMPOSITION			
% STOCKING [— 10-40%, ≡ 40-70%, ≡ 70-100%]			
HT. CLASS RANGE			
COMMENTS:			

COMMENTS: (FIRE SCARS EXTENT OF SCORCH, ETC...)

INDICATOR SPECIES

- HAZELNUT
- MADRONE
- MANZANITA
- OCEAN SPRAY
- POISON OAK
- BALDHIP ROSE
- SNOWBERRY
- WHIPPLEVINE
- TALL OREGON GRAPE
- DWARF ORE. GRAPE
- PRINCES PINE
- SALAL
- TWINFLOWER

Figure C-2 Field data collection sample form

VOLUME DETERMINATION

Standing volumes were derived from the Willamette National Forest's Mature and Over-mature stand-typing Contract Number R6-18-87-428. Stands were typed utilizing 1:12000 aerial photographs. The following is a list of stand level attributes and appropriate tolerance levels acceptable under the provisions of the contract:

STAND ATTRIBUTE	TOLERANCE
Canopy layer size class	95 percent of all stands accurately classified
Stocking class by crown layer	Total number of trees/acre +50 (95 percent of stands must be correctly classified)
Canopy closure by crown class	Closure within +10 percent
Crown diameters by crown layer	r+15 percent
Total stand volume	Photo interpreted total stand volume (cubic feet to a 6-inch top) + 5,000 cubic feet
Species composition by layer	Listing of species which contribute more than 20 percent to total canopy closure by layer

DEFINITION OF CROWN LAYER

First Layer:	Dominant and codominant trees.
Second Layer:	Trees with heights between 40 and 75 percent of the height of the codominant trees.
Third Layer:	Trees with heights less than 40 percent of codominant trees.

A layer was recorded when the crowns of trees in the appropriate height category form more than 5 percent of the total stand canopy closure.

The stand level attributes previously described were directly ascribed to stands outside the fire area and within the analysis area. Stand level attributes within the fire area were derived from a composite of field data (see Figure C-2), Mature and Over-Mature contract data, McArdle (1961) yield tables, aerial photo mensurational tables (Dilworth 1959) (Figure C-3), and comparative cruises from past sales in or near the analysis area.

VCD (ft) TOTAL HEIGHT IN FEET

	70	80	90	100	110	120	130	140	150	160	170	180
D.B.H. in INCHES												
8	7.8	8.8	9.9	10.9	11.9	13.0						
11	9.6	10.6	11.7	12.7	13.8	14.8	15.9	16.9				
14	11.4	12.5	13.5	14.6	15.7	16.7	17.8	18.8	19.9	21.0		
17	13.2	14.3	15.4	16.5	17.5	18.6	19.7	20.8	21.8	22.9	24.0	25.1
20		16.1	17.2	18.3	19.4	20.5	21.6	22.7	23.8	24.9	25.9	27.0
23			19.1	20.2	21.3	22.4	23.5	24.6	25.7	26.8	27.9	29.0
26			20.9	22.0	23.1	24.3	25.4	26.5	27.6	28.7	29.9	31.0
29			22.7	23.9	25.0	26.1	27.3	28.4	29.5	30.7	31.8	33.0
32				25.7	26.8	28.0	29.2	30.3	31.5	32.6	33.8	34.9
35					28.7	29.9	31.1	32.2	33.4	34.6	35.7	36.9

Combined data -- OSU, McDonald Forest and Pope & Talbot, Inc.'s data collected in Clackamas and Multnomah Counties, OR. Prepared by the multiple regression method. Based on 1,554 trees. Site indexes 100-170. J.R. Dilworth, 1959.

Relationship between DBH-VCD-TH for second-Ggowth Douglas-fir trees in medium and well-stocked stands.

VCD (ft) TOTAL HEIGHT OF TREE IN FEET

	70	80	90	100	110	120	130	140	150	160	170	180
Volume of tree, (Scribner) Board Feet to 8" Top D.I.B.												
8					137	190						
11			98	142	200	255	326	408				
14		97	142	194	255	321	402	498	613	754		
17	87	139	190	249	312	389	481	598	721	876	1058	1266
20		172	235	303	377	460	566	693	836	1011	1212	1435
23			286	362	448	537	653	790	952	1144	1370	1627
26			335	420	511	619	742	893	1071	1282	1527	1813
29			388	486	584	696	836	998	1195	1441	1693	1999
32				551	658	780	930	1106	1325	1572	1864	2171
35					737	871	1028	1219	1465	1726	2030	2363

Developed from Table No.14 USDA Bulletin No. 201, and D.B.H. Curves. Includes Trees 11.6 inch D.B.H. and larger. Combined data -- OSU, McDonald Forest and Pope & Talbot, Inc.'s data collected in Clackamas and Multnomah Counties, Oregon. Based on 1,554 trees. Site indexes 100-170. J.R. Dilworth, 1959.

Figure C-3 Aerial photo mensurational tables. Board foot photo-volume table for second-growth Douglas-fir trees in medium and well-stocked stands.

TIMBER VOLUME DETERIORATION

PRIMARY DAMAGING AGENTS

Major causes of fire-killed tree deterioration are fungi, insects, and weathering. These agents can attack trees singly but usually work in combination. This is especially true of fungi and insects which often form symbiotic relationships.

DETERIORATION PROCESS

Fire-killed trees that are left standing generally follow a natural progression of decay. The time this takes varies according to a number of factors, primarily species and diameter. Insects, such as bark beetles and wood borers, are the first to start this process. Fungi are often introduced either by being transported by the insects or through the bore holes they create. These fungi thrive in an ideal environment afforded by the warm and moist conditions beneath the bark.

Sapwood, which is the first area to be affected by both beetles and fungi, is the most susceptible portion of the tree. Staining, which is caused by fungi, occurs within the first year and progresses into the sapwood. Staining generally affects the appearance of the wood, subsequently reducing lumber value but not necessarily the lumber volume. Some species of flathead borers and roundhead borers mine in the sapwood and often progress into the heartwood. The early staining and insect boring results primarily in log-grade reductions. As both beetles and fungi progress, they generally work 360 degrees around the tree towards the heartwood. The heartwood is more resistant to insects and fungal decay than sapwood.

Heartwood is dryer and more dense but, over time, will be bored through and/or rotted. Volume loss follows value lost with respect to deterioration of the heartwood.

In addition to insects and fungi, weathering is another cause of deterioration due to checking and splitting. Trees with smaller diameters and thinner bark are affected first.

FACTORS AFFECTING DETERIORATION RATE

Species:

Species vary in bark thickness, wood-fiber strength, moisture content, percent of sapwood, and host specific insects and fungi. The following is a list of species listed in decreasing order of deterioration resistance:

incense cedar
Douglas-fir
sugar pine
ponderosa pine
true firs, western hemlock

Diameter:

Trees with small diameters (less than 20 inches) have less physical mass, a higher percentage of sapwood, and, generally, thinner bark. The fact that insects, fungi, and checking simply have less wood to penetrate, coupled with the higher percentage of sapwood, makes small-diameter trees extremely vulnerable to deterioration.

Moisture:

Fungi will spread most rapidly in a moist environment. This ideal environment is provided within the sapwood of recently dead trees. However, too much moisture can retard fungi by limiting oxygen. Dry sites will also retard the deterioration process caused by fungi. Conversely, these same dry sites will increase checking and splitting in tops and small diameter thin-barked trees.

Temperature:

Fungi grow well within a temperature range of 41 to 95 degrees F. The optimum range for growth is 45 to 70 degrees F. This temperature range, along with optimum moisture, is a major factor affecting rate of fungal growth.

Aspect/Elevation:

These factors are important in that they relate to fungal growth indirectly by affecting moisture and temperature. Higher elevation or north aspects will have a slowing effect on the rate of fungal growth providing the temperature is below 41 degrees F for a significant period of time.

Individual Species Deterioration Rates:

Volume and value loss for Douglas-fir is graphically displayed in Figures C-4 and C-5. Deterioration losses for other minor species, such as incense cedar, sugar pine, Ponderosa pine, grand fir, and western hemlock, are not displayed as their volume contribution to predicted mortality is nominal.

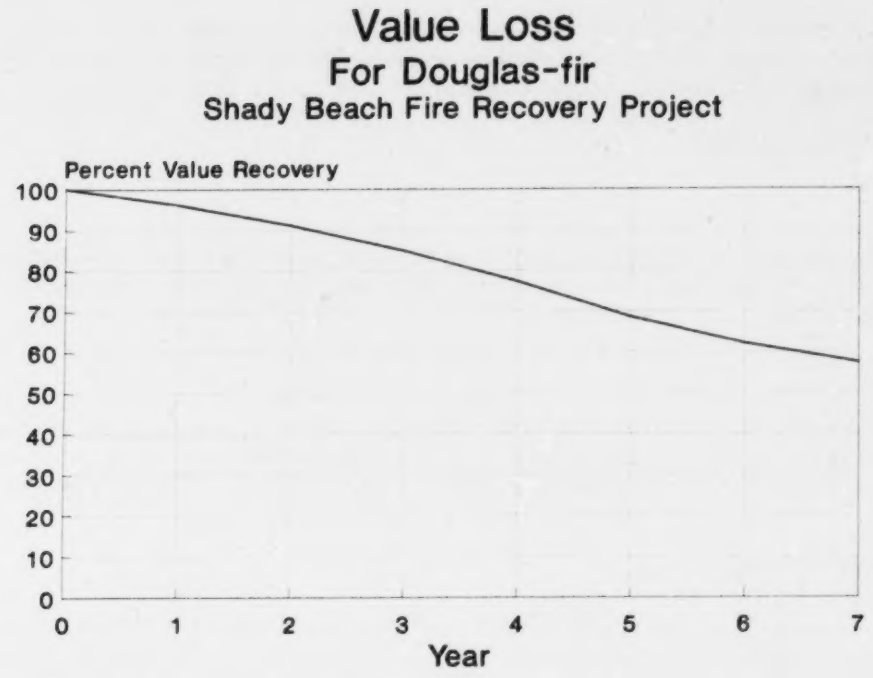


Figure C-4 Value loss for Douglas-fir

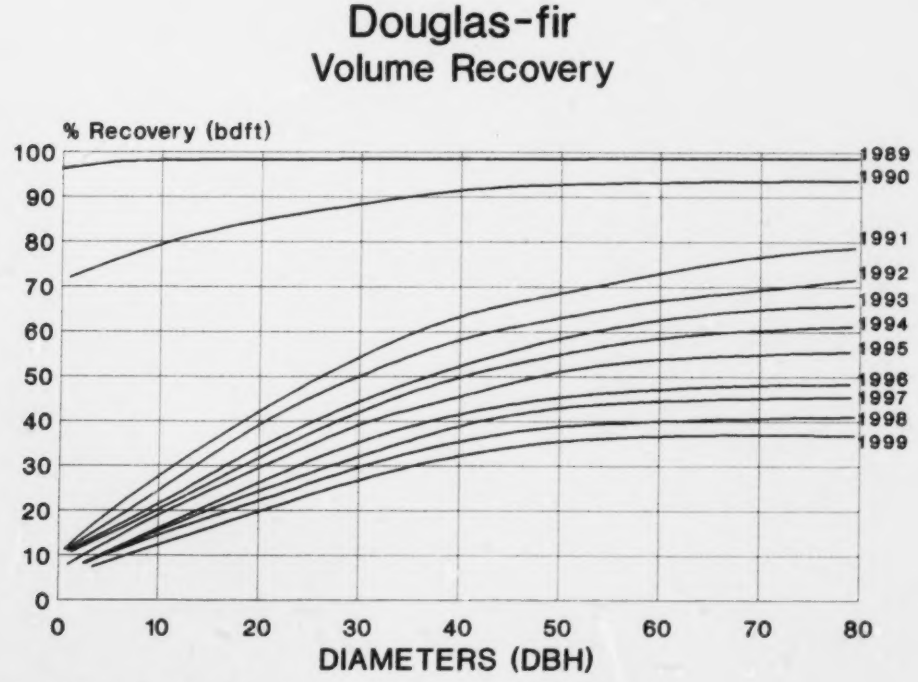


Figure C-5 Douglas-fir volume recovery

INSECTS ASSOCIATED WITH FIRE-KILLED AND DAMAGED TREES

Douglas-fir

There are several insects associated with fire-killed and damaged Douglas-fir. The species of importance can be classified as either those which will cause additional tree mortality following the fire or those whose primary impact will be through degrade of the already dead trees. The insects that can cause additional tree mortality are the Douglas-fir beetle and the flatheaded fir borer. The insects which will bore into the sapwood and heartwood and cause degrade are the ambrosia beetles, the flatheaded borers, and the roundheaded borers.

The Douglas-fir beetle, *Dendroctonus pseudotsugae*, is the major insect of concern. This insect normally occurs in endemic levels in downed, weakened, or diseased trees but can briefly build up to outbreak levels following a stand disturbance such as a blowdown or fire. The bark beetle spends most of its life in the cambium region just beneath the bark. The adults, which are reddish-brown and about 1/4-inch-long, fly and attack weakened trees in the spring between April and June.

The preferred host is downed Douglas-fir, but this beetle will also attack weakened or dying trees. The adult beetles construct an egg gallery beneath the bark and lay eggs in niches along the length of the gallery. When these eggs hatch, the larvae mine and feed in the cambium and pupate. When they become adults, they will emerge and attack new host trees the following spring. In areas where large amounts of host material occur at one time, such as large areas of blowdown or fire, populations can build up to high levels. If there is no fresh, down, or dying material for these emerging adults to infest, they will attack adjacent standing green trees. Douglas-fir beetles do not, however, thrive well in standing dead or normal green timber. Resistance of the host and the poor success of the brood in standing green trees keeps the beetle at endemic levels. Even when outbreaks occur following a blowdown, populations abruptly subside once they attack green timber.

The second insect that can cause additional tree mortality is the flatheaded fir borer, *Melanophila drummondi*. The adult, a flattened, black beetle with a metallic sheen, is about 3/8-inch long. This beetle attacks in the early summer following a fire. The larvae of this insect also mines into the cambium and can girdle a tree. Although it most often inhabits trees that are already dead, it will also attack and kill stressed, weakened, or scorched trees. Trees adjacent to a burned area can also be affected. It is less important, however, than the Douglas-fir beetle.

Insects that will bore into the sapwood of recently dead trees and cause degrade include the ambrosia beetles or pinhole borers. (Healthy green trees are not affected.) Of these, the most important is the striped ambrosia beetle, *Trypodendron lineatum*. The defect caused by the beetle consists of small holes surrounded by a dark stain. Galleries are constructed within the sapwood with larval cradles constructed along the main gallery. The larvae live in these "cradle galleries" and feed on the ambrosia fungus which is introduced by the female as it constructs the galleries. Attacks are marked by piles of fine, white, boring dust in the bark crevices. Attacks begin in March, reach a peak in May, and continue into August. Prompt harvesting of logs prior to and during the flight period will minimize attacks.

Other ambrosia beetles of the species *Gnathotrichus* also attack and bore into the sapwood; but these are of lesser importance than the striped ambrosia beetles because they have galleries that are smaller in diameter, fewer in number, and less stained. They attack from April through November, but primarily in the spring and late summer.

There are a number of species of flatheaded borers and roundheaded borers that mine in the sapwood and, in some cases, in the heartwood of fire-killed trees. Attacks initially occur within the first few years after the fire but can continue for 4 or 5 years, as long as the wood remains sound. The damage to the sapwood and heartwood from these insects, along with fungal deterioration, can be the factor in determining the limit of practical salvage in an area. The golden buprestid, *Buprestis aurulenta*, is one of the most damaging of this species because it mines in wood that has not been kiln-dried. Years of mining can cause major structural damage. In the forest, the life cycle lasts for several years, however, development can take from 30 to 50 years in buildings.

Ponderosa pine and sugar pine

As with Douglas-fir, there are some insects that will attack and kill damaged and weakened trees, and others that will mine in the sapwood and heartwood of the pines. The western pine beetle, *Dendroctonus brevicomis*, often attacks ponderosa pine weakened by drought, disease, or fire. Populations can build up and will continue to attack apparently healthy green trees. Adults attack during the late spring and will continue until stopped by cold weather. The beetle introduces blue stain fungus when it attacks. The larvae mine the inner bark, girdling and killing the tree. Sanitation/salvage is often used, where practical, to minimize the damage from this beetle. The mountain pine beetle, *Dendroctonus ponderosae*, will attack both ponderosa and sugar pines. It is less often associated directly with fire-damaged trees. In areas with a higher percent of pine, the impact from this insect may be more important.

Beetles of the species *Ips* may also be found in conjunction with other bark beetles. They can attack trees that have been killed or severely damaged by fire. However, outbreaks are of short duration and usually do not last for more than 1 year.

Ambrosia beetles and flatheaded and roundheaded borers will also attack and mine in the pines causing degrade. Some of the flatheaded borers in the pine areas are actually "smoke chasers"; they are attracted to fires and lay their eggs on scorched and sometimes smoldering trees.

INSECT ACTIVITY FOLLOWING FIRE

Although there are a number of evaluations documenting insect activity following blowdown in the Pacific Northwest, there is much less information available on activity following fire. The Tillamook fires could be considered a worse-case scenario on insect activity following fire. From 1929 to 1933, a series of large fires near Tillamook, Oregon, created a continued source of damaged and weakened trees for Douglas-fir beetle populations. In the spring of 1935, adults emerged from the last of the fire-damaged trees and attacked green trees along the fringes of the burns. In addition, spots of dying trees occurred several miles into the interior of the green stands adjacent to the burn areas. By 1936, the beetle populations had abruptly declined (Furniss, 1936; Furniss, 1937).

In a study in Idaho, Furniss (1965) examined the relationship of bark beetle attack and fire injury. He found that Douglas-fir killed outright were not attractive to Douglas-fir beetles. The trees most susceptible to attack were those with moderate-to-heavy cambium damage. Seventy percent of the trees examined were attacked by beetles. Of these, 88 percent were considered successful attacks; however, brood production was low because of adverse conditions under the bark, such as pitch invasion into brood galleries and "sour sap." He also verified the tendency for crown injury and cambium injury to be correlated. This allows the use of crown damage as a guide to assessing fire injury. Douglas-fir trees 16 inches DBH and larger are more susceptible to bark beetle attack than those with smaller diameters. The larger trees will also be the greater brood producers.

Guidelines for identifying fire-injured ponderosa pine are also discussed in Furniss (1965) and Wagener (1961). Ponderosa pine can survive more damage than Douglas-fir; however, trees with more than 50 percent crown damage are susceptible to bark beetle attack.

REFORESTATION

Considerable acreage within the Shady Beach fire area is representative of the Douglas-fir climax plant association. Inherent reforestation concerns of Douglas-fir climax sites include:

Soils: Soil textures vary from thin, gravelly loams (ravel-prone slopes) to heavy clays depending upon topography.

> Gravelly/cobbly loams: These soils pose a high potential for bare root stock desiccation as a result of the high content of coarse, fractured basalt in the surface soils (poor root/soil contact). Container-grown stock will be considered to ameliorate such conditions.
>
> Clays: Fine-textured clays become very cemented and can hold soil water at tensions greater than 15 bars (wilting coefficient). This results in high plant-moisture stresses sufficient to cause mortality under droughty summer conditions. Another reforestation problem inherent with clay soils concerns the restricted planting window. Clay soils must be planted at the proper soil moisture or survival and growth will be affected. Increased granulation of clay soils (organic matter incorporation) ameliorates the cohesion and plasticity problems. Container-grown stock will be considered to ameliorate such conditions.

Vegetative Competition

Grasses: Grass competition with conifers varies depending on whether the grasses are annuals or perennials.

> Annuals: This type of grass exhibits a very rapid growth rate early in the season at low soil temperatures. They can very effectively utilize the available soil water in their rooting zone (12 to 16 inches) before the initiation of conifer root growth.
>
> Perennials: These grasses are sod-forming and can effectively use available water within a 12- to 24-inch rooting zone. They display similar root-growth initiation at low temperatures as annuals. Measures to control brush competition will be implemented as necessary. Measures may include mulching, the use of chemicals, or mechanical release.

Other potential competitors on Douglas-fir climax sites include madrone, big-leaf maple, chinquapin, hairy-manzanita, and deer and buck brush.

Solar Radiation:

> Excessive solar radiation on south and west aspects may develop lethal tissue temperatures in the root-collar area of newly planted conifers. Therefore, it may be necessary to provide shade (either natural or artificial) for the conifer stem near the soil line.

Animal Control:

The fire area lies within deer and elk winter range. Growth loss from browsing can be expected unless protection measures are provided.

MINIMUM RESIDUAL STOCKING LEVELS

The purpose and need of the proposed action is to implement recovery projects to salvage fire-killed or damaged timber while protecting other resource values and to reforest salvage areas quickly in order to maintain the long-term biological potential.

In order to maintain the long-term biological potential of the area, in terms of timber volume and growth potential, understocked sites should be converted to fast-growing, thrifty plantations. Understocking is a quantitative measure of tree density, expressed in relation to normal numbers of basal area or volume per acre. The ideal or most effective number and distribution of trees is called normal or full stocking.

Therefore, minimum residual stoking levels, following the fire, are acceptable near the lower end of the normal stocking range. This insures that growth is concentrated on the fewest number of stems without losing growth on a per acre basis through understocking. Harvest cuts which produce excessively open conditions underutilize the site's capabilities. Ideally, residual volumes should by held within an optimal range (Langsaeter's Zone III, Figure C-6). Within Zone III, stand growth rate changes very slowly in spite of increasing stand volume. The lower end of Zone III occurs at about 60 percent of normal. Retaining standing volume at densities less than 60 percent of normal would result in an underutilized site. (See Figure C-7). Such stands should be harvested and converted to plantations to more effectively utilize the site's potential.

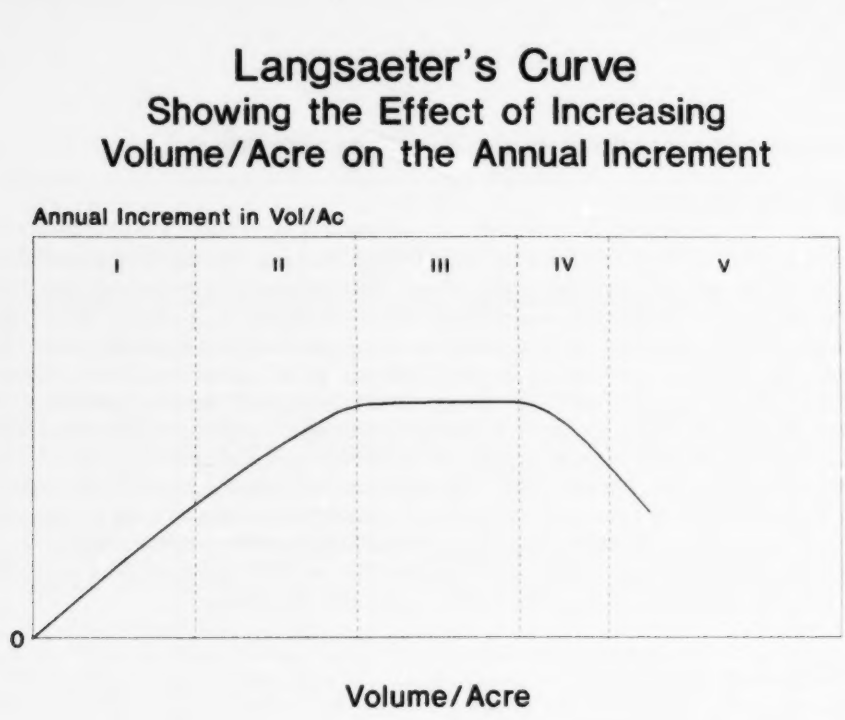


Figure C-6 Langsaeter's Curve showing the effect of increasing volume per acre on the annual increment. (Actual values are not important, but the principle is important in the silvicultural manipulation of a stand.)

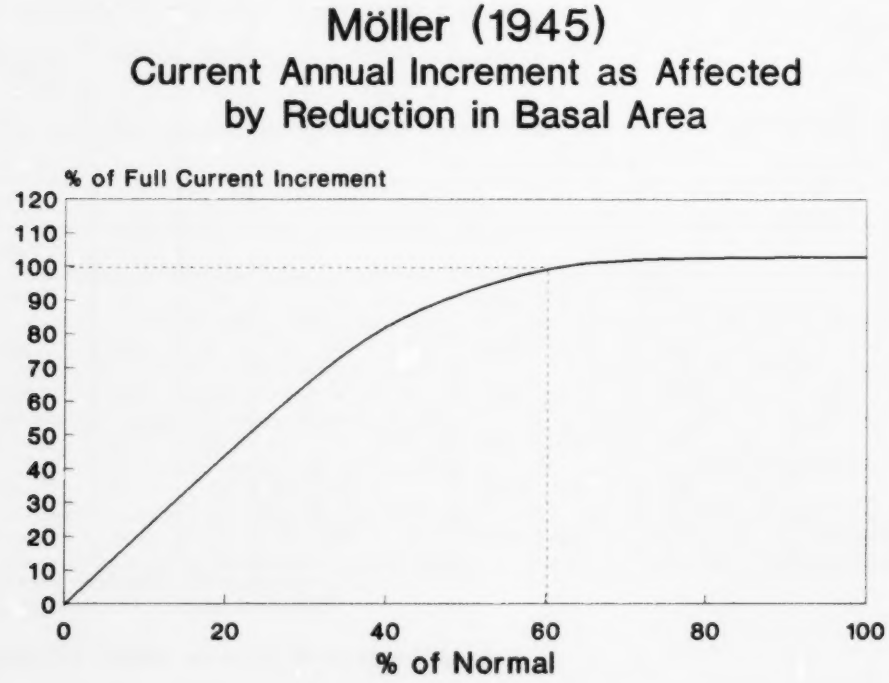


Figure C-7 Reduction in basal area of stand. Volume densities less than 60 percent of normal.

STAND DEVELOPMENT AND GROWTH

ALTERNATIVE E - NO ACTION

Conifer stocking of pioneer species would be substantially delayed due to the environmental variables interacting to reduce crop-tree establishment and survival. It is estimated that 20 to 30 years would be required to establish a well-stocked stand of conifers in a "free to grow " state. The growth response of unlogged stands consisting of outright mortality is displayed in 10-year increments in Figure C-8. At the end of an 80-year analysis period, standing green volume would approximate 12.0 MBF gross merchantable volume (GMV) per acre in areas where the previous stand was destroyed by fire. Eighty years is the average prescribed rotation length on the Willamette National Forest (culmination of the mean annual and periodic annual increment). These stands would cover about 2,199 acres. About 4,129 acres of stands with partial mortality and stands unaffected by the fire would be harvested according to the normal sale planning process at a harvest rate of 20 percent per decade as specified in the Proposed Forest Plan/DEIS. Volume yield in the harvest of these stands would approximate 32 to 48 MBF GMV per acre. It is assumed that dead trees would deteriorate beyond recovery under this alternative.

GROWTH RESPONSE OF UNLOGGED STANDS

CALENDAR YEAR	STAND AGE	DBH 1)	HT	10 YR RADIAL INCREMENT 20TH	BA/ TREE	# TREES	PROJECTED BASAL AREA	INTERIM/FINAL COMMERCIAL ENTRY VOL/ACRE GMV* REMOVED
1989	200	20	110	7	2.1817	160	350	
1999	210	20.7	113	7	2.3371	152	355	
2009	220	21.4	116	7	2.4978	144	360	
2019	230	22.1	119	7	2.6639	136	362	
2029	240	22.8	122	7	2.8353	128	363	
2039	250	23.5	125	7	3.0121	120	360	54.4 MBF
2041	1					680		
2051	11	2	15	40.0	0.0218	280	6.1	
2061	21	7	34	45	0.2673	280	74.8	
2071	31	9.5	60	25	0.4922	280	137.8	6.7 MBF

GROWTH RESPONSE OF UNLOGGED OUTRIGHT MORTALITY STANDS

CALENDAR YEAR	STAND AGE	DBH 1)	HT	10 YR RADIAL INCREMENT 20TH	BA/ TREE	# TREES	PROJECTED BASAL AREA	INTERIM/FINAL COMMERCIAL ENTRY VOL/ACRE GMV* REMOVED
1989								
1999								
2009								
2019	10	1.1	11	19	0.0066	1210	7.9	
2029	20	3	18	19	0.0491	1078	52.9	
2039	30	4.9	24	19	0.1310	946	123.9	
2049	40	6.8	34	17	0.2522	680	171	
2059	50	8.5	50	18	0.3941	496	195	
2069	60	10.3	66	18	0.5780	380	219	12.0 MBF

1) McArdle Yield Tables (Interpolation)
*GMV = Gross merchantable volume MBF

Figure C-8 Growth response of unlogged stands

Regeneration Harvest Regime - ALTERNATIVES B, C, D, AND F

CLEARCUT METHOD (CONVENTIONAL HARVEST SYSTEMS): The stand development and growth response of the 2,552 clearcut acres to be harvested by conventional logging systems is displayed in Figure C-9. Planted stands would be precommercially thinned to approximately 280 trees per acre (12- by 12-foot spacing) at Age 12. The first commercial thinning opportunity would occur at an approximate stand Age of 42. This commercial thinning would yield about 6,400 MBF/acre GMV, leaving a residual stocking level of 170 trees per acre (TPA). The second commercial thinning would occur at stand Age 62 and yield approximately 20 MBF/acre. Residual stocking levels following the second commercial entry would be 70 TPA. The final harvest would yield about 35 MBF/acre GMV at stand Age 80. Under this intensive management growth modeling scheme, total volume yield would approximate 61.6 MBF/acre GMV at the end of the 80-year rotation.

GROWTH RESPONSE OF MANAGED STANDS (S.I.130)
(Conventional Logging System)

CALENDAR YEAR	STAND AGE	DBH	HT	10 YR RADIAL INCREMENT 20TH	BA/ TREE	# TREES	PROJECTED BASAL AREA	INTERIM/FINAL COMMERCIAL ENTRY VOL/ACRE GMV* REMOVED
2001	12	2	15	40	.0218	280	6.1	
2011	22	7	34	45	.2673	280	74.8	
2021	32	9.5	60	25	.4922	280	137.8	
2031	42	12.0	78	25	.7854	170	219.9	6.4 MBF
2041	52	14.5	91	25	1.1467	170	194.9	
2051	62	17.0	101	25	1.5763	70	276.9	20 MBF
2061	72	19.5	110	25	2.0739	70	145.2	
2071	82	22.0	120	25	2.6398	70	184.8	35.2 MBF

*GMV = Gross merchantable volume MBF

Figure C-9 Growth response of managed stands (conventional logging)

CLEARCUT METHOD (HELICOPTER HARVEST SYSTEM): The stand development and growth response of the 254 clearcut acres utilizing helicopter yarding is displayed in Figure C-10. These stands would be extensively managed due to the difficulty in accessing such areas for cultural treatments. They would be precommercially thinned to approximately 134 trees per acre (18- by 18-foot spacing). This crop tree density would be carried to rotation as commercial thinning entries are not anticipated on extensively managed stands. The final and total yield under this extensive management scheme would approximate 54.4 MBF/acre GMV at stand Age 80.

GROWTH RESPONSE OF MANAGED STANDS
(Helicopter)

CALENDAR YEAR	STAND AGE	DBH	HT	10 YR RADIAL INCREMENT 20TH	BA/ TREE	# TREES	PROJECTED BASAL AREA	INTERIM/FINAL COMMERCIAL ENTRY VOL/ACRE GMV* REMOVED
2001	12	2	15	40	0.0218	134 (1)	2.9	
2011	22	7	34	45	0.2673	132	35.3	
2021	32	9.5	60	25	0.4922	128	63.0	
2031	42	12.0	78	25	0.7854	124	97.4	
2041	52	14.5	91	25	1.1467	120	137.6	
2051	62	17.0	101	25	1.5763	116	182.9	
2061	72	19.5	110	25	2.0739	112	232.3	
2071	82	22.0	120	25	2.6398	108	285.1	54.4 MBF

(1) Thinned to 18- by 18-feet spacing
*GMV = Gross merchantable volume MBF

Figure C-10 Growth response of managed stands (helicopter)

SHELTERWOOD METHOD (CONVENTIONAL HARVEST SYSTEMS): Stand development and growth of the shelter wood regeneration system utilizing conventional harvest systems would be the same as the conventional clearcutting system in terms of stand development. The shelterwood harvest method is a regeneration cut designed to provide site-amelioration on areas which are difficult to reforest. Where prescribed, the shelterwood system is designed to reduce excessive solar radiation on predominately south aspects. Excessive solar radiation may result in lethal tissue temperatures in the root collar area of newly-planted conifers. Retention of approximately 50 percent of the original overstory shade would be necessary to provide the necessary seedling protection. This would involve leaving an average of 16 MBF/acre GMV of the existing stand to provide this shade. Removal cuts would be scheduled before the planted seedlings exceed 18 inches in height. The smaller and more flexible the seedlings are, the better their chance to survive logging damage. The shelterwood harvest method would apply to 195 acres under Alternative B.

PARTIAL CUT HARVEST REGIME (CONVENTIONAL HARVEST SYSTEMS): The stand development and growth response of the 1,457 acres of prescribed partial cutting utilizing conventional harvest systems is displayed in Figure C-11. The resultant, partially stocked stands would be scheduled to be harvested beginning in the second decade, following the initial partial harvest, and would yield 41.2 MBF/acre GMV. In 20 years, the partial cut stands would receive a regeneration harvest cut and be artificially regenerated. Planted stands would be precommercially thinned to approximately 280 TPA at stand Age 11 (chronological Age 31). The first commercial thinning opportunity would occur at stand Age 41 (chronological Age 61), yielding about 6.4 MBF/acre GMV. Stocking density at stand Age 60 (chronological Age 80) amounts to 36.8 MBF/acre GMV.

GROWTH RESPONSE OF PARTIAL CUT STANDS
(Conventional Logging Systems)

CALENDAR YEAR	STAND AGE	DBH	HT	10 YR RADIAL INCREMENT 20TH	BA/ TREE	# TREES	PROJECTED BASAL AREA	INTERIM/FINAL COMMERCIAL ENTRY VOL/ACRE GMV* REMOVED
1989	200	32	167	7	5.5851	23	128.5	
1999	210	32.7	170	7	5.8321	23	134.1	
2009	220	33.4	170	7	6.0844	23	139.9	41.2 MBF
2011	1	0				680		
2021	11	2	15	40	.0218	280	6.1	
2031	21	7	34	45	.2673	280	74.8	
2041	31	9.5	60	25	.4922	280	137.8	
2051	41	12.0	78	25	.7854	170	219.9	6.4 MBF
2061	51	14.5	91	25	1.1467	170	194.9	
2071	61	17.0	101	25	1.5763	170	267.9	36.3 MBF

*GMV = Gross merchantable volume MBF

Figure C-11 Growth response of partial cut stands (conventional logging)

PARTIAL CUT HARVEST REGIME (HELICOPTER HARVEST SYSTEM): The stand development and growth response of the 237 acres of prescribed partial cutting utilizing helicopter yarding is displayed in Figure C-12. Partially stocked stands, which are scheduled to be harvested in the second decade following the initial partial harvest, would yield 41.2 MBF/acre GMV. In about 20 years, the partial cut stands would be regeneration harvested and artificially regenerated. Planted stands would be planted to 12- by 12-foot spacing and precommercially thinned to 18- by 18-foot spacing. This crop tree density would be carried to rotation as commercial thinning entries are not anticipated in extensively managed stands. Stocking density at stand Age 60 (chronological Age 80) amounts to 24.8 MBF/acre GMV.

Analyzing volume yield and timing during a specific period of time gives the silviculturist a tool to compare growth and yield differences between the prescribed harvest methods.

GROWTH RESPONSE OF PARTIAL CUT STANDS
(Helicopter)

CALENDAR YEAR	STAND AGE	DBH	HT	10 YR RADIAL INCREMENT 20TH	BA/ TREE	# TREES	PROJECTED BASAL AREA	INTERIM/FINAL COMMERCIAL ENTRY VOL/ACRE GMV* REMOVED
1989	200	32	167	7	5.5851	23	128.5	
1999	210	32.7	170	7	5.8321	23	134.1	
2009	220	33.4	170	7	6.0844	23	139.9	41.2 MBF
2011	1					302 (1)		
2021	11	2	15	40	0.0218	134 (2)	2.9	
2031	21	7	34	45	0.2673	132	35.3	
2041	31	9.5	60	25	0.4922	128	63.0	
2051	41	12.0	78	25	0.7854	124	93.4	
2061	51	14.5	19	25	1.1467	120	137.6	
2071	61	17.0	101	25	1.5763	116	181.3	24.8 MBF

(1) Planted to 12- by 12-feet spacing
(2) Thinned to 18- by 18-feet spacing
*GMV = Gross merchantable volume MBF

Figure C-12 Growth response of partial cut stands (helicopter)

NO-CUT REGIME: The stand development and growth response of the 1,633 non-harvested acres is displayed in Figure C-8. Under Alternative B, the uncut stands would be harvested in the fourth and fifth decades. Volume realization in the fifth decade would be approximately 54.4 MBF/acre GMV. At this point, they would be regeneration harvested and replanted. Planted stands would be precommercially thinned at Age 11 (chronological Age 61). Volume yield at the end of the analysis period (80 years) would be 6.7 MBF/acre GMV and the stand would be 31 years old.

WILDLIFE - BIG-GAME - HABITAT QUALITY INDEX

SHADY BEACH FIRE RECOVERY PROJECT
OAKRIDGE, OREGON
By
Berntina Steele, Wildlife Biologist

BACKGROUND

The area burned by the Shady Beach fire was predominantly a mosaic of habitat types with hiding cover and forage areas dispersed throughout the majority of the thermal cover areas. The dispersion and amount of forage areas were variable within the project area. Some subwatersheds had been intensively managed and had a relatively large proportion of forage and hiding cover areas. Some subdrainages had not been intensively managed and had proportionately less forage and hiding cover and more thermal cover and optimum thermal cover areas. As a result some subwatersheds had a relatively higher capacity for production of deer and elk during average winters, and some subwatersheds had relatively lower capacity, given average conditions, but higher resiliency to effects of severe winter events.

Cover was destroyed in areas where fire intensities were high, but the process for development of an abundance of high-quality forage was set in motion.

Cover on lightly burned areas was also reduced in quality. However, the remaining cover quality was still high. Portions of the understory vegetation were destroyed by the fire in these stands. Most understory vegetation will redevelop in about 5 to 15 years. However, it is not expected to exceed pre-fire levels because canopy closure in these stands will still be relatively high. The dominant habitat role of lightly burned stands will continue to be a provision of cover.

An index was developed to measure relative changes in big-game habitat capacity resulting from the fire and proposed treatments. The index uses the quantity and quality of food and cover and its usability by big-game animals to show relative changes in capacity. The model, developed by the Forest Service in cooperation with the Oregon Department of Fish and Wildlife and the Bureau of Land Management (Wisdom and others, l986), was used in these analyses. The Wisdom model was refined by information from the analysis of the USDA Forest Service, Silver Fire Recovery Project, Appendix D (1988) and information from Harshman (1978). Excerpts included in this paper were taken directly from Wisdom and others (1986) and the USDA Forest Service, Silver Fire Recovery Project (l988).

INDEX LIMITATIONS

The index, which was developed to measure relative changes in big-game habitat capacity, has limitations:

1. The index measures relative changes in habitat capacity.

2. The trends and the differences in index values between alternatives provide, in our professional judgement, reasonable estimates of what is expected to happen on the ground. For example, if an index value is 25 percent higher than another value, then:

    a. We have confidence that there is an increase in capacity.
    b. We do not believe that the 25 percent value is the absolute answer. However, the answer is probably around 25 percent.

3. The index process cannot capture small changes in habitat capacity. Small differences in index values (for example, .125 versus .130) probably are not meaningful. Difference in values of .020 or .030 indicate meaningful changes in habitat capacity.

4. Interactions resulting from logging or reforestation are difficult to quantify, therefore the following assumptions were made:

   a. Areas that were moderately or intensively burned and treated with the clearcut method will cause an immediate increase in logging debris which could hamper big-game movement. However, in the untreated state, this material would accumulate as trees fall. Harvest treatments including clearcutting and shelterwood cutting, when combined with slash treatment, are expected to result in areas having higher forage quality and an abundance but lower cover quality than untreated areas.

   b. Tree-felling and yarding, especially with tractor and skyline systems, will destroy new vegetation and disturb the soil. These areas are expected to revegetate. The early stages of succession on these disturbed sites will be prolonged. All areas burned with 90 to 100 percent mortality will be identified as forage recruitment in 1988. Areas with lower than 90 percent mortality, that are proposed for timber salvage, will be identified as forage recruitment in 1990.

   c. Conifer-planting will decrease the length of time areas remain in the early stages of succession (forage). However, by Years 12 to 15, when conifer competition with grasses, forbs, and shrubs becomes great, the quality of most forage will have declined. Planted conifers will accelerate cover recovery. Cut-over and burned-over areas with 90 to 100 percent mortality will be considered forage for 20 years, and forage quality indices will reflect changes in forage over that 20-year period. Areas cut-over or burned-over with 90 to 100 percent mortality will be considered hiding cover between Years 20 and 49 and thermal cover at Year 50, if canopy closure is sufficient to provide thermal-buffering capacity.

Overview of the process

Changes in the quality and quantity of big-game forage are measured over time. Major forest stand types each have a forage and cover value which changes over time. Fire-caused changes in forest stand types created a new set of forage or cover values, which also change over time.

Timber harvesting increases or decreases forage or cover values in a forest stand and, consequently, increases or decreases big-game use. Harvesting effects can be short- or long-term.

Human disturbance caused by timber harvesting can also modify the use of forage or cover by big game. Disturbance can come from the logging activity itself or from roads developed for timber access. If roads remain open to motorized vehicle use, big-game use adjacent to roads declines.

The index measures relative changes in the quantity and quality of big-game forage over a 22-year period, starting in 1988. Three sets of conditions were measured:

1. The conditions which existed prior to the fire.
2. The conditions which were created by the fire.
3. The conditions which would be created by harvest.

The quantity and quality of habitat created by the fire was modified to account for reductions in use expected on large acreages with high intensity burn and which contained little or no internal cover.

The quantity and quality of habitat created by the fire was then modified to account for the effects of logging or roads.

The process works as follows:

Four major variables are considered to significantly affect big-game habitat and the utilization of that habitat. These variables are:

1. Size and spacing: Overall size of forage and cover areas and their spatial arrangement.
2. Road Density: Disturbance from road systems open to traffic.
3. Forage Quality: Availability of quality forage within forage areas resulting from fire and/or harvest treatments and time of development beyond that treatment.
4. Cover Quality: Effectiveness of cover areas for hiding, snow interception and temperature moderation, as reflected by stand age, dominant tree size class, canopy closure, and canopy layering.

The four major habitat variables are affected by changes in the landscape that develop, over time, and that result from impacts of the fire and from harvest activity associated with salvage of fire-damaged timber. Changes which are anticipated to affect habitat variables include:

1. Succession of forage areas to hiding-cover areas.
2. Succession of hiding cover areas to thermal-cover areas.
3. Succession of thermal cover areas to optimum thermal-cover areas.
4. Aging of cover adjacent to roads and increased cover effectiveness.
5. Forage quantity increases resulting from high-fire intensity.
6. Forage quantity and quality increases resulting from harvest with slash treatment.
7. Forage quantity and quality decreases resulting from harvest without slash treatment.
8. Forage quality increases resulting from forage-enhancement projects such as seeding, fertilization, forage planting, and browse cut-back.
9. Cover decreases from high-fire intensity.
10. Cover decreases from harvest activity.
11. Disturbance from existing roads not closed to traffic.
12. Disturbance from new roads not closed to traffic.
13. Reduced disturbance by closing existing and/or new roads to traffic.
14. Disturbance from logging activity.

Each of the four major variables is represented by an index. Each index represents the relative ability of the analysis area to provide habitat assets which contribute toward maximizing big-game production. The four indices are then combined to give a Habitat Quality Index (HQI). (See Figures D-1A through D-1F on pages D-13 to D-18.) It provides for a relative comparison of an analysis area's ability to produce healthy populations and maximum numbers of big-game animals during average winter conditions. The size and spacing index combined with the cover quality index also provides for identification of areas with superior severe winter resiliency.

Analysis Area and Time Period

The overall analysis area consists of the aggregation of the boundaries of all subwatersheds that were affected by the Shady Beach fire. Each subwatershed was analyzed separately as an independent analysis area.

Major water bodies, rock outcrops, and talus slopes were excluded from the analysis, since they do not contribute significantly to forage or cover needs. With the above exceptions, all land within the Project Area Boundary was utilized for the analysis, regardless of ownership or management responsibility.

Indices were calculated for each subwatershed within the Shady Beach Project Area.

The time period selected for analysis was 0 to 22 years. Pre-fire Year 0 represents pre-fire conditions present before the Shady Beach fire. Post-fire Year 0 represents post-fire conditions resulting after the Shady Beach fire. Year 22 is the time when all forage created by harvesting or mortality by Year 2 evolves from significant forage production to low-forage value or hiding cover.

INDEX PARTS

Variable 1: Size and spacing of forage and cover areas.

As discussed in the background information section, the interspersion and amount of forage areas and cover areas were variable within the project area before the fire. The intensity of the fire, predicted mortality, and resultant expectation for forage recruitment and cover reduction is also variable within the project area.

The way that forage and cover are interspersed affects the time and energy required by big-game to fully utilize both habitat components and to reach security cover when disturbing factors are present. (See Figure D-2 on page D-19.) Maximum intake and the least expenditure of energy occurs when forage and cover are of appropriate size and proximity. This results in maximum energy available for maintenance, growth, and reproduction. During average winters, areas further from the forage-cover edge are utilized less than areas near the forage-cover edge. During average winters, as forage and cover areas become larger than optimum, less of the total area is used by big game (Figure D-3 on page D-20 and Figure D-4 on page D-21).

However, cover areas that do not exceed 100 yards from the edge with forage (less than 200 yards wide) receive less than optimum use (Figure D-5 on page D-21). Size and Spacing Indices range from 1.0 for high value to 0.1 for low value and are derived from a combination of values for forage areas and cover areas. Analysis for this variable is based on the assumption of average winters. Thus, it must be kept in mind that the highest index value derived for this variable (for average winters) may not represent the most optimum condition for severe winters. During severe winters, the more effective thermal moderation provided by larger thermal cover blocks is expected to become more critical. Those watersheds that have high-forage size and spacing index and low-cover size and spacing index will be identified. It is those areas that will have less than maximum big-game production capacity during average winters, but will have higher resistance to severe winter stress than subwatersheds with maximum big-game capacity during average winters.

Forage blocks and cover areas were arranged spatially in a computerized analysis layer (Figure D-6 on page D-22). Cover areas less than 200 yards wide were identified on the computerized analysis layer. The computer then delineated bands at 100-yard intervals from the forage-cover edge in all forage areas and in all cover blocks exceeding 200 yards in width (Figure D-7 on page D-23 and Figure D-8 on page D-24). Effectiveness values were assigned for each distance-to-edge band (Figure D-9 on page D-25). The acreage in each distance-to-edge band was calculated and multiplied by the representative effectiveness value. Thus a Size and Spacing Index value was determined for each subwatershed for Pre-fire Year 0, Post-fire Year 0, and for the cumulative analysis periods. For alternatives which differed from Post-fire Year 0 impact to forage-cover boundaries, a size and spacing index was also derived. This would be the case for any alternatives that harvested outside of the 90 to 100 percent mortality areas with clearcut or shelterwood treatments.

Variable 2: Road density open to motorized vehicles.

Big-game use of habitat is dramatically and adversely affected by roads open to vehicular traffic. Any road open to motorized vehicles was included in the calculation of road density. Only permanently closed roads were excluded from road-density analysis.

A shortage of cover in cutover areas and in intensively burned areas further reduces the utilization of forage and cover areas in proximity to roads. It will take 17 years after cutting or burning for hiding cover to approximate pre-fire or pre-harvest levels. The area impacted by lack of cover is greater for roads in age classes 0 to 17 years, than for age classes 18 years or older. Lower fire intensities reduce hiding cover, but not as significantly as cutover treatment or 90 to 100 percent mortality burned over (outright mortality).

Within the Shady Beach fire area, fire intensity and resultant timber mortality was substantially less outside of the 90 to 100 percent mortality burned areas. For this reason, all unharvested stands outside of the 90 to 100 percent mortality areas were considered to have the same reduction in use along roads as unburned stands 18 years of age or older. Tree removal in light-to-moderately burned areas will reduce the quality of hiding cover and consequently use by big game. Alternative designs which incorporate timber harvest along road systems or closure of road systems to traffic were evaluated individually.

The area within 200 feet on each side of roads open to traffic receives about 25 percent of normal use in stands exceeding 17 years of age. In cut or intensively burned areas, the affected strip is expanded to 300 feet on each side of the road. Using an average road width of 18 feet, then the total width affected is 418 feet for stands 18 years or older and 618 feet for stands 0 to 17 years:

$$\text{Acres affected} = \frac{\text{(miles of road in feet X width in feet)}}{\text{43,560 sq.ft. per acre}}$$

Acres affected by 0 to 17 are 618 feet wide.
Acres affected by 18+ are 418 feet wide.
Total acres affected = acres affected by 0 to 17 + acres affected by 18+.

The Road Density Index (RDI) is expressed as a decimal between 1.0 and 0.1 and is equal to the reciprocal of the percentage of the total acres in the analysis area which is acres affected by roads.

$$RDI = 1.0 \frac{\text{(analysis area acres)}}{\text{(acres affected by roads)}}$$

For example, if the analysis area was 1,000 acres and 1 mile of road was in the 0 to 17 class and 2 miles of road were in the 18+ age class:

1. Acres affected 0-17 = $\frac{\text{(1 mi x 5280 ft/mi x 618 ft)}}{\text{43,560 sq.ft. per acre}}$ = 75 acres

2. Acres affected 18+ = $\frac{\text{(2 mi x 5280 ft/mi x 418 ft)}}{\text{43,560 sq.ft. per acre}}$ = 101 acres

3. Total acres affected = 75 + 101 = 176

4. RDI = 1.0 - (176 divided by 1000) = 1.0 - 0.176 = .824

The lower the percentage of the analysis area that is affected by roads the higher the RDI.

Variable 3: Forage quality.

The conditions of forest stands were described by the survey crews during the post-fire inventory effort. Forest Service biologists then assigned forage quality values to each stand type based on the stand description, treatment history, and forage-unit age.

Forage values are based on treatments applied and age of opening. The scale in which these assigned values occur ranges from 1.0 to 0.1. Opening age modifies silvicultural treatment values. Opening-age ratings range from 1.0 for high-availability and high-quality forage in openings 0 to 8 years of age to 0.5 for low-availability and low-quality forage in openings 16 to 20 years old.

Treatment ratings range from 1.0 to 0.1. At the high end are units that have been clearcut, burned, forage-seeded, and fertilized, or burned, harvested, slash-piled, forage-seeded, and fertilized. These promote high availability of high-quality forage. On the low end are units that have been partially cut with no slash treatment, unseeded, or unfertilized areas. These units restrict availability and do not induce high-forage quality. Standard silvicultural practices common to the area, clearcutting with slash treatment but without forage enhancement, would rate at 0.5 on a scale of 0.1 to 1.0. Addition of forage seeding would bring the rating to .75 and seeding with fertilization would rate at 1.0 for a high forage quality index. Clearcutting without slash removal is expected to rate at .25.

Natural meadows provide a natural forage production area which will maintain forage production for many years if forest encroachment is controlled and the plant communities are protected from degradation. Actions which could result in meadow degradation include poorly managed livestock grazing, roading, log skidding, off-road vehicles, and other sources of accelerated erosion. Untreated meadow areas rate at .75, whereas fertilized meadow areas rate 1.0 in forage quality for big game. Rock outcrops, talus slopes, and the reservoir are not considered to contribute significantly to forage or cover, and they have been excluded from the analysis.

FORAGE QUALITY BEFORE THE FIRE

The forage areas available before the fire and those scheduled to become forage areas by timber harvest plans were categorized by forage quality for Years 0, 9, and 22. These are points in time that allow tracking of changes in the forage quality of the stand.

Year 0 Pre-fire (1988)

High-Forage Value: Grasses, forbs, and shrubs are very abundant and readily accessible to big-game animals. Many of these stands are tree plantations on former clearcut areas. Plants that are young or mature receive high amounts of sunlight and have high palatability and nutritional value. This forage class includes harvest areas with slash treatment that are 0 to 8 years of age and natural meadow areas.

Moderate-Forage Value: Grasses and forbs are less abundant and forage shrubs are reaching maturity. New growth of shrubs is palatable and nutritious, but older shrub growth is coarse and of low palatability. This forage class includes harvest areas with slash treatment that are 9 to 15 years of age.

Low-Forage Value: Grasses and forbs are scarce in these areas and forage shrubs are tall and coarse. New growth of shrubs is out of the animals' reach. The majority of the forage available is coarse browse or new growth with limited abundance. This forage class includes harvest areas with slash treatment that are 16 to 20 years of age. A limited number of harvest units which did not receive slash treatment also fall into this category due to restrictions in accessibility to and production of high-quality forage.

Year 9: (1997)

High-Forage Value: Only stands that were harvested since 1989, and natural meadows in good condition will remain in this category. All harvest units which existed in Year 0 will no longer be in the high-forage value class.

Moderate-Forage Value: All stands that were 6 years of age or less in Year 0 will be in this category.

Low-Forage Value: All stands that were 7 to 11 years of age at Year 0 will be in this category, and all stands that were greater than 11 years at Year 0 will drop out of forage production.

Year 22: (2010)

High-Forage Value: There will be no stands created by timber harvest in this forage class. Only natural meadows in good condition would remain in this category.

Moderate-Forage Value: There will be no stands in this forage class.

Low-Forage Value: Only stands harvested in 1990 will remain in this category. All other forage areas will have gone out of forage production. Beyond Year 22, there will be no stands in significant forage production. Only natural meadows will contribute to forage needs. Intensive forage enhancement through selective harvest or browse cutback and fertilization will be necessary if forage value is to be regained.

FORAGE QUALITY AFTER THE FIRE

Year 0: (1988)

High-Forage Value: Grasses, forbs, and shrubs are very abundant. Many of these stands are tree plantations on former clearcut areas. Plants that are young or mature receive high amounts of sunlight and have high palatability and nutritional value. These stands include:

*Unburned harvest areas 0 to 8 years of age.
Natural meadows in good condition.
Outright mortality areas with harvest or slash treatment.

Moderate-Forage Value:

*Unburned harvest areas 9 to 15 years of age.

Low-Forage Value: Grasses, forbs, and shrubs which occur in relatively low densities, under high canopy closure, are "old" and have low palatability or nutritional value. Also included in this category are newly created forage areas with slash loading which inhibits accessibility and forage production. These stands include:

*Unburned harvest areas 16 to 20 years of age.
Outright mortality areas without harvest or slash treatment.

*For post-fire evaluation unburned harvest areas refers to harvest units that were not burned at high intensity by the Shady Beach wildfire. "Unburned" does not refer, in this section, to a lack of slash treatment at time of harvest.

Year 9: (1997)

High-Forage Value: Only harvest areas which were harvested since 1989 and natural meadows in good condition will remain in this category. All fire timber salvage areas which included clearcutting and shelterwood cutting with slash treatment will remain in this category, but all harvest areas that existed in Year 0 will no longer be in high forage value class.

Moderate-Forage Value: All unburned harvest areas that were 6 years of age or less at Year 0 will be in this category. Forage areas created by high-intensity burning in 1988 will be in this category if they received slash treatment.

Low-Forage Value: All unburned harvest areas that were 7 to 11 years of age at Year 0 will be in this category. All fire salvage areas which did not receive slash treatment, and all fire salvage thinnings will be in this category. All forage areas created by high intensity burning that did not receive slash treatment will be in this category. All unburned harvest areas that were greater than 11 years of age at Year 0 will drop out of forage production.

Year 22: (2010)

High-Forage Value: Only natural meadows in good condition will be in this category.

Moderate-Forage Value: There will be no stands in this forage class.

Low-Forage Value: Only stands harvested in 1990 will remain in this category. All other forage areas will have gone out of forage production. Beyond Year 22, there will be no stands in significant forage production. Only natural meadows will contribute to forage needs. At that time intensive forage enhancement through selective harvest, thinning, or browse cutback and fertilization will be necessary if forage value is to be regained.

FORAGE QUALITY VALUES

Forage Quality Values are attributed to each area based on treatments applied and age since the treatment. Treatments include harvest strategies: burning by wildfire, slash treatment, seeding, and/or fertilization. Stand condition prior to burning is included in this section as it affects the slash loading potential of the forage areas.

The following is a list of Forage Quality Values that were used in determining the Forage Value Index for each area:

Unburned (no mortality/less than 90 percent Predicted Mortality)

0-8 yr	CC, B, S, F	1.00
9-15 yr	CC, B, S, F	0.80
16-20 yr	CC, B, S, F	0.50
0-8 yr	CC, B, F	0.75
9-15 yr	CC, B, F	0.60
16-20 yr	CC, B, F	0.40
0-8 yr	CC, B	0.50
9-15 yr	CC, B	0.40
16-20 yr	CC, B	0.25
0-8 yr	CC	0.25
9-15 yr	CC	0.20
16-20 yr	CC	0.10
0-8 yr	SH	0.20
9-15 yr	SH	0.15
16-20 yr	SH	0.10

Burned intensively (90 to 100 percent Predicted Mortality)

0-8 yr	OM, S, F	1.00
9-15 yr	OM, S, F	0.80
16-20 yr	OM, S, F	0.50
0-8 yr	OM, F	0.75
9-15 yr	OM, F	0.60
16-20 yr	OM, F	0.40
0-8 yr	OM	0.50
9-15 yr	OM	0.40
16-20 yr	OM	0.25
C1,C2,C3	OM	0.25
C1,C2,C3	OM, CC	0.25
C1,C2,C3	OM, CC, SL	0.50
C1,C2,C3	OM, CC, SL, F	0.75
C1,C2,C3	OM, CC, SL, S	0.75
C1,C2,C3	OM, CC, SL, F, S	1.00
C1,C2,C3	OM, F, S	0.40

Where: C1=optimal thermal cover, C2=thermal and hiding cover, C3=narrow cover strips, OM=outright (100%) mortality, CC=clearcut, SH=shelterwood cut, B=prescribed broadcast burn, S=forage seeded, F=fertilized, and SL=slash treated.

Any other possible treatment combinations developed during alternative formulation will be based upon the same principles and will be assigned forage values accordingly.

The acres in each forage quality category are divided by the total acres of the analysis area (expressed as a decimal) to derive a Forage Quantity Value.

Multiplying the Forage Quality Values times the Forage Quantity Values provides a Forage Value Index. (FQV.1xFQV.2=FVI). The Forage Value Index is then included in the Habitat Quality Index (HQI).

200 acres 0.50, 0.5 x 200 acre/440 = .23.
100 acres 0.30, 0.3 x 100 acre/440 = .07.
100 acres 0.80, 0.8 x 100 acre/440 = .18.
40 acres 1.00, 1.0 x 40 acre/440 = .09. Total FVI = .57.

Variable 4: Cover Quality

There are three major types of cover used by big-game animals: optimum thermal cover, thermal cover, and hiding cover. Optimum thermal cover is defined as forest stands with multiple canopy layers and overstory canopy capable of intercepting and holding a substantial amount of snow and with some capability to provide forage during periods when food in other areas in unavailable due to weather extremes or human disturbance. These criteria are generally achieved when dominant trees average 21 inches or greater in diameter at breast height (DBH) and have a total canopy closure of 70 percent or greater.

In the project area, it is anticipated that these characteristics will be present in stands 120 years of age or older. Thermal cover has some temperature moderation, snow-holding capacity and a limited provision of litterfall forage, but is not as effective as optimum thermal cover. Thermal cover characteristics are thought to be achieved in the project area in stands 50 to 119 years of age and with total canopy closure of 70 percent or greater. Hiding cover is capable of providing security cover for escape from harassment and predators, but it has little or no effectiveness in temperature moderation, snow-holding capacity, and forage provision.

To evaluate cover quality, values were assigned to conditions present in stands of timber in the analysis area. Stands were evaluated based on stand age, canopy closure, predicted mortality, and effective width.

Cover Effectiveness Values were assigned to each cover types as follows:
1) optimum thermal cover - 1.0; 2) thermal cover - 0.5;
3) thermal cover affected by minimum width - 0.3; and 4) hiding cover - 0.1.

The acres in each cover quality category divided by the total acres in cover provides a Cover Quantity Value.

Multiplying the Cover Effectiveness Value times the Cover Quantity Value provides a Cover Value Index (CVI) which is applied to the Habitat Quality Index (HQI).

Calculation of Habitat Effectiveness:

A number of potential relationships can exist between habitat variables in a multivariate evaluation model. To obtain one index of habitat effectiveness, all variables must be integrated to explain the species response to a wide range of habitat conditions.

The interactions between sizing and spacing, road density, cover quality, and forage quality appear to be compensatory. However, high scores in some variables do not fully compensate for low scores in other variables. Big-game animals primarily respond to and are limited by habitat variables of low value, with secondary but not full compensation by variables of higher value. The arithmetic mean value of individual variable scores can only be used when high scores fully compensate low scores. In big-game habitat, quality analysis where high values only partially compensate effects of low values, the geometric mean is used instead of the arithmetic mean.

The equation for integrating habitat variables to derive a HQI via the use of a geometric mean is as follows:

$$HQI = (SSI \times RDI \times FVI \times CVI)^{1/N}$$

where: HQI = Habitat Quality Index.
SSI = Size and Spacing Index.
RDI = Road Density Index.
FVI = Forage Value Index.
CVI = Cover Value Index
1/N = Nth root of the product taken to obtain the geometric mean
where N = the number of habitat variables

Interpretation of the Results:

The HQI value derived from the equation in the previous section can be used to provide a relative comparison of capability of areas to provide high-quality habitat for big-game animals. The analysis can be used to evaluate relative differences between different analysis areas (subwatersheds) within the project area or to evaluate relative differences within an analysis area predicted to occur under different management strategies.

The HQI values can range between 1.0 and 0.05, with 1.0 being the highest possible effectiveness for big-game production and values at or below 0.1 being very poor for big-game production and likely nonviable.

Figure D-10 can be used to help interpret the results of an evaluation and to aid in decisionmaking.

Habitat Quality Index	Habitat Condition
1.0	Optimal
0.9 0.8 0.7 0.6	Highly Viable
0.5 0.4	Viable
0.3 0.2	Marginal
0.1 0.05	Possibly Nonviable

Figure D-10 HQI values

The percent change in HQI can be used as a measure of change in habitat effectiveness, over time or after implementation of management plans, to evaluate potential success or impacts of management plans, and to establish trends in habitat condition:

Percent change in HQI = ((x-y)/x)100)
where x = HQI at Time 1 (or pre-treatment)
y = HQI at time 2 (or post-treatment)

In addition to the HQI values derived during the analysis, there are other habitat indicators which should be considered during the evaluation and decisionmaking process.

As discussed in the Background, Overview, and Variable 1 Sections, the Size and Spacing Index in this model is designed to evaluate optimal conditions during average weather conditions. Analysis areas with high forage area Size and Spacing indices and low cover area Size and Spacing indices will have a moderate overall Size and Spacing Index (based on average weather conditions). They will be effective in providing the additional thermal moderation, snow-holding capacity, and alternative forage provision that will be critical during periods of severe winter weather conditions.

Any of the four habitat variables may act as a limiting factor when habitat effectiveness value for that variable drops below 0.20. In such cases, the probability of maintaining viable habitat for big game will be lowered significantly. During analysis, any habitat variable with values below 0.20 indicate a situation which may result in non-viability for big-game habitat regardless of the overall HQI value. In such cases, the reason for the low value should be taken into consideration during the decisionmaking process. Any activity which further reduces the value should be avoided and mitigation measures to restore the value to a higher level should be recommended.

This model evaluates elk habitat from a broad perspective, and special habitats or areas used intensively by elk during certain seasons may not be fully recognized. Areas of special use that are known to occur in certain analysis areas should be identified, and their importance assessed and displayed along with HQI.

HQI INDICES
PRE-FIRE

Subwatershed	Year	FSS	CSS	SSI	RDI	FVI	CVI	N	HQI
21A	0	.93(X.16=.15)	.78(X.84=.66)	.81	.74	.48	.68	4	0.665
	9	1.0(X.14=.14)	.79(X.86=.68)	.82	.74	.40	.68	4	0.637
	22	.96(X.06=.05)	.43(X.94=.41)	.46	.77	.25	.61	4	0.482
21B	0	.91(X.24=.22)	.93(X.76=.71)	.93	.68	.52	.47	4	0.627
	9	1.0(X.14=.14)	.86(X.86=.72)	.86	.69	.37	.75	4	0.637
	22	.93(X.06=.05)	.51(X.94=.48)	.53	.71	.25	.62	4	0.491
22B	0	.93(X.22=.20)	.81(X.78=.63)	.83	.68	.46	.54	4	0.612
	9	1.0(X.15=.15)	.91(X.85=.77)	.92	.70	.42	.53	4	0.615
	22	.93(X.08=.07)	.55(X.92=.51)	.58	.73	.25	.46	4	0.470
22B	0	.90(X.27=.25)	.91(X.73=.66)	.91	.61	.40	.57	4	0.596
	9	1.0(X.07=.07)	.56(X.93=.52)	.59	.63	.33	.51	4	0.500
	22	.91(X.04=.03)	.37(X.96=.36)	.39	.66	.75	.51	4	0.560
22D	0	.90(X.28=.25)	.92(X.72=.66)	.91	.60	.44	.60	4	0.616
	9	1.0(X.18=.18)	.82(X.82=.67)	.85	.60	.36	.56	4	0.566
	22	1.0(X.00=.00)	.20(X1.0=.20)	.20	.66	.75	.47	4	0.464
22P	0	.56(X.47=.27)	.96(X.53=.51)	.78	.61	.47	.94	4	0.677
	9	.90(X.40=.36)	.94(X.60=.56)	.92	.62	.36	.94	4	0.663
	22	1.0(X.00=.00)	.21(X1.0=.21)	.21	.70	.75	.72	4	0.531
22Q	0	.69(X.37=.26)	.91(X.63=.57)	.83	.61	.46	.52	4	0.590
	9	.95(X.35=.33)	.90(X.65=.59)	.92	.61	.45	.48	4	0.590
	22	.93(X.12=.11)	.65(X.88=.57)	.68	.68	.25	.51	4	0.493
22R	0	.91(X.27=.25)	.97(X.73=.71)	.96	.73	.46	.55	4	0.649
	9	1.0(X.20=.20)	.89(X.80=.71)	.91	.73	.34	.52	4	0.585
	22	0.00	.25(X1.0=.25)	.25	.77	0.00	.49	4	0.000

FSS = Forage Size & Spacing
CSS = Cover Size & Spacing
SSI = Size & Spacing Index
RDI = Road Density Index
FVI = Forage Value Index
CVI = Cover Value Index
N = Number of Habitat Variables
HQI = Habitat Quality Index

Figure D-1A

HQI INDICES
ALTERNATIVE E (NO ACTION)

Subwatershed	Year	FSS	CSS	SSI	RDI	FVI	CVI	N	HQI
21A	0	.85(X.31=.26)	.87(X.69=.59)	.85	.72	.41	.79	4	0.633
	9	.84(X.31=.26)	.87(X.69=.60)	.32	.72	.32	.77	4	0.488
	22	.97(X.05=.04)	.30(X.95=.29)	.33	.77	.25	.57	4	0.436
21B	0	.91(X.24=.22)	.91(X.76=.69)	.91	.68	.52	.54	4	0.646
	9	.92(X.21=.20)	.89(X.79=.70)	.90	.69	.37	.53	4	0.591
	22	.93(X.05=.05)	.48(X.95=.45)	.50	.71	.25	.60	4	0.480
22B	0	.67(X.48=.32)	.77(X.52=.40)	.72	.65	.38	.74	4	0.602
	9	.68(X.44=.30)	.76(X.56=.42)	.72	.66	.30	.50	4	0.517
	22	.98(X.01=.01)	.32(X.99=.32)	.33	.73	.25	.44	4	0.403
22C	0	.53(X.57=.30)	.79(X.43=.34)	.64	.56	.35	.63	4	0.530
	9	.51(X.57=.29)	.77(X.43=.33)	.62	.57	.25	.61	4	0.482
	22	1.0(X.00=.00)	.21(X1.0=.21)	.21	.66	.75	.33	4	0.430
22D	0	.88(X.29=.25)	.89(X.71=.63)	.88	.60	.44	.75	4	0.646
	9	.91(X.23=.21)	.90(X.77=.69)	.90	.60	.36	.70	4	0.607
	22	1.0(X.00=.00)	.20(X1.0=.20)	.20	.66	.75	.57	4	0.487
22P	0	.34(X.75=.26)	.84(X.25=.21)	.47	.59	.40	.58	4	0.504
	9	.34(X.75=.25)	.84(X.25=.21)	.46	.59	.29	.58	4	0.462
	22	1.0(X.00=.00)	.21(X1.0=.21)	.21	.70	.75	.72	4	0.399
22Q	0	.86(X.65=.56)	.90(X.35=.32)	.88	.59	.38	.77	4	0.624
	9	.70(X.45=.31)	.82(X.55=.45)	.76	.59	.31	.75	4	0.568
	22	.93(X.12=.10)	.64(X.88=.56)	.66	.68	.25	.62	4	0.513
22R	0	.90(X.32=.29)	.94(X.68=.64)	.93	.73	.44	.63	4	0.659
	9	.90(X.30=.27)	.87(X.70=.61)	.88	.73	.33	.61	4	0.600
	22	0.00	.23(X1.0=.23)	.23	.77	0.00	.52	4	0.000

FSS = Forage Size & Spacing
CSS = Cover Size & Spacing
SSI = Size & Spacing Index
RDI = Road Density Index
FVI = Forage Value Index
CVI = Cover Value Index
N = Number of Habitat Variables
HQI = Habitat Quality Index

Figure D-1B

HQI INDICES
ALTERNATIVE B

Subwatershed	Year	FSS	CSS	SSI	RDI	FVI	CVI	N	HQI
21A	0	.85(X.32=.27)	.97(X.68=.66)	.93	.59	.52	.57	4	0.635
	9	.85(X.33=.28)	.97(X.67=.65)	.93	.58	.25	.57	4	0.527
	22	.97(X.05=.04)	.30(X.95=.29)	.33	.67	.25	.28	4	0.353
21B	0	.92(X.22=.20)	.96(X.78=.75)	.95	.67	.50	.54	4	0.644
	9	.91(X.23=.22)	.93(X.77=.70)	.92	.67	.36	.53	4	0.586
	22	.93(X.05=.05)	.48(X.95=.45)	.50	.69	.25	.58	4	0.473
22B	0	.67(X.48=.29)	.79(X.56=.44)	.73	.51	.34	.53	4	0.509
	9	.676X.44=.29)	.76(X.56=.44)	.73	.51	.27	.49	4	0.471
	22	.98(X.01=.01)	.32(X.99=.32)	.33	.63	.25	.26	4	0.341
22C	0	.51(X.57=.28)	.90(X.43=.39)	.67	.46	.34	.49	4	0.476
	9	.53(X.56=.30)	.85(X.44=.37)	.67	.48	.26	.47	4	0.445
	22	0.00	.21(X1.0=.21)	.21	.59	.75	.24	4	0.386
22D	0	.92(X.25=.23)	.92(X.75=.69)	.92	.59	.43	.74	4	0.645
	9	.88(X.27=.24)	.92(X.73=.67)	.91	.57	.36	.70	4	0.601
	22	0.00	.20(X1.0=.20)	.20	.64	.75	.56	4	0.482
22P	0	.34(X.76=.45)	.98(X.24=.24)	.69	.44	.36	.17	4	0.369
	9	.34(X.75=.26)	.97(X.25=.24)	.50	.41	.27	.17	4	0.311
	22	0.00	.21(X1.0=.21)	.21	.58	.75	.11	4	0.317
22Q	0	.67(X.50=.33)	.99(X.50=.50)	.83	.53	.37	.69	4	0.579
	9	.69(X.49=.34)	.98(X.51=.50)	.84	.54	.30	.67	4	0.549
	22	.93(X.12=.11)	.64(X.88=.56)	.67	.63	.25	.48	4	0.474
22R	0	.90(X.30=.27)	.98(X.70=.68)	.95	.69	.39	.52	4	0.604
	9	.90(X.32=.28)	.91(X.68=.62)	.90	.68	.29	.50	4	0.546
	22	0.00	.23(X1.0=.23)	.23	.73	0.00	.21	4	0.000

FSS = Forage Size & Spacing
CSS = Cover Size & Spacing
SSI = Size & Spacing Index
RDI = Road Density Index
FVI = Forage Value Index
CVI = Cover Value Index
N = Number of Habitat Variables
HQI = Habitat Quality Index

Figure D-1C

HQI INDICES
ALTERNATIVE C

Subwatershed	Year	FSS	CSS	SSI	RDI	FVI	CVI	N	HQI
21A	0	.85(X.32=.27)	.97(X.68=.66)	.93	.65	.32	.62	4	0.588
	9	.85(X.33=.28)	.97(X.67=.65)	.93	.63	.25	.62	4	0.549
	22	.97(X.05=.04)	.30(X.95=.29)	.33	.72	.25	.40	4	0.393
21B	0	.92(X.22=.20)	.96(X.78=.75)	.95	.67	.50	.54	4	0.644
	9	.91(X.23=.22)	.93(X.77=.70)	.92	.67	.36	.97	4	0.681
	22	.93(X.05=.05)	.48(X.95=.45)	.50	.70	.25	.58	4	0.475
22B	0	.67(X.44=.29)	.79(X.56=.44)	.73	.53	.33	.52	4	0.508
	9	.67(X.44=.29)	.76(X.56=.44)	.73	.52	.26	.49	4	0.469
	22	.98(X.01=.01)	.32(X.99=.32)	.33	.64	.25	.26	4	0.342
22C	0	.51(X.57=.28)	.90(X.43=.39)	.67	.46	.33	.49	4	0.472
	9	.53(X.56=.30)	.85(X.44=.37)	.67	.48	.25	.61	4	0.471
	22	0.00	.21(X1.0=.21)	.21	.60	.75	.24	4	0.388
22D	0	.92(X.25=.23)	.92(X.75=.69)	.92	.60	.43	.74	4	0.647
	9	.88(X.27=.24)	.92(X.73=.67)	.91	.57	.36	.70	4	0.601
	22	0.00	.20(X1.0=.20)	.20	.64	.75	.56	4	0.482
22P	0	.34(X.76=.45)	.98(X.24=.24)	.69	.49	.33	.16	4	0.366
	9	.34(X.75=.26)	.97(X.25=.24)	.50	.46	.27	.16	4	0.316
	22	0.00	.21(X1.0=.21)	.21	.62	.75	.11	4	0.322
22Q	0	.67(X.50=.33)	.99(X.50=.50)	.83	.55	.37	.69	4	0.584
	9	.69(X.49=.34)	.98(X.51=.50)	.84	.55	.34	.67	4	0.570
	22	.93(X.12=.11)	.64(X.88=.56)	.67	.65	.25	.48	4	0.478
22R	0	.90(X.30=.27)	.98(X.70=.68)	.95	.69	.38	.51	4	0.597
	9	.90(X.32=.28)	.91(X.68=.62)	.90	.67	.29	.49	4	0.541
	22	0.00	.23(X1.0=.23)	.23	.73	0.00	.86	4	0.000

FSS = Forage Size & Spacing
CSS = Cover Size & Spacing
SSI = Size & Spacing Index
RDI = Road Density Index
FVI = Forage Value Index
CVI = Cover Value Index
N = Number of Habitat Variables
HQI = Habitat Quality Index

Figure D-1D

HQI INDICES
ALTERNATIVE D

Subwatershed	Year	FSS	CSS	SSI	RDI	FVI	CVI	N	HQI
21A	0	.85(X.32=.26)	.87(X.69=.59)	.85	.72	.33	.42	4	0.540
	9	.84(X.31=.26)	.87(X.69=.60)	.32	.71	.27	.42	4	0.401
	22	.97(X.05=.04)	.30(X.95=.29)	.33	.77	.25	.30	4	0.372
21B	0	.91(X.24=.22)	.91(X.76=.69)	.91	.68	.48	.56	4	0.639
	9	.92(X.21=.20)	.89(X.79=.70)	.90	.67	.36	.53	4	0.582
	22	.93(X.05=.05)	.48(X.95=.45)	.50	.71	.25	.30	4	0.404
22B	0	.67(X.44=.32)	.77(X.52=.40)	.72	.65	.36	.50	4	0.539
	9	.68(X.44=.30)	.76(X.56=.42)	.72	.64	.28	.49	4	0.501
	22	.98(X.01=.01)	.32(X.99=.32)	.33	.73	.25	.30	4	0.367
22C	0	.53(X.57=.30)	.79(X.43=.34)	.64	.56	.35	.46	4	0.490
	9	.51(X.57=.29)	.77(X.43=.33)	.62	.58	.25	.45	4	0.448
	22	0.00	.21(X1.0=.21)	.21	.66	.75	.25	4	0.402
22D	0	.88(X.29=.25)	.89(X.71=.63)	.88	.60	.43	.74	4	0.640
	9	.91(X.23=.21)	.90(X.77=.69)	.90	.57	.36	.70	4	0.600
	22	0.00	.20(X1.0=.20)	.20	.63	.75	.56	4	0.480
22P	0	.34(X.75=.26)	.84(X.25=.21)	.47	.59	.34	.13	4	0.333
	9	.34(X.75=.25)	.84(X.25=.21)	.46	.56	.28	.13	4	0.311
	22	0.00	.21(X1.0=.21)	.21	.70	.75	.11	4	0.332
22Q	0	.86(X.65=.56)	.90(X.35=.32)	.88	.60	.36	.60	4	0.581
	9	.70(X.45=.31)	.82(X.55=.45)	.76	.59	.29	.59	4	0.526
	22	.93(X.12=.11)	.64(X.88=.56)	.67	.68	.25	.49	4	0.486
22R	0	.90(X.30=.29)	.94(X.68=.64)	.93	.73	.40	.52	4	0.613
	9	.90(X.30=.27)	.87(X.70=.61)	.88	.71	.28	.50	4	0.544
	22	0.00	.23(X1.0=.23)	.23	.77	0.00	.43	4	0.000

FSS = Forage Size & Spacing
CSS = Cover Size & Spacing
SSI = Size & Spacing Index
RDI = Road Density Index
FVI = Forage Value Index
CVI = Cover Value Index
N = Number of Habitat Variables
HQI = Habitat Quality Index

Figure D-1E

HQI INDICES
ALTERNATIVE F

Subwatershed	Year	FSS	CSS	SSI	RDI	FVI	CVI	N	HQI
21A	0	.85(X.31=.26)	.93(X.69=.64)	.90	.67	.34	.77	4	0.630
	9	.85(X.32=.27)	.93(X.68=.63)	.90	.66	.26	.77	4	0.587
	22	.97(X.05=.04)	.30(X.95=.29)	.33	.73	.25	.52	4	0.421
21B	0	.91(X.24=.22)	.91(X.76=.69)	.91	.67	.50	.54	4	0.637
	9	.92(X.21=.20)	.89(X.79=.70)	.90	.67	.36	.53	4	0.582
	22	.93(X.05=.05)	.48(X.95=.45)	.50	.71	.25	.60	4	0.480
22B	0	.67(X.44=.30)	.77(X.76=.71)	.73	.54	.33	.71	4	0.551
	9	.66(X.44=.29)	.76(X.56=.43)	.72	.56	.27	.67	4	0.520
	22	.98(X.01=.01)	.32(X.99=.32)	.33	.64	.25	.39	4	0.379
22C	0	.53(X.54=.29)	.89(X.46=.41)	.70	.49	.32	.59	4	0.504
	9	.52(X.57=.30)	.87(X.43=.37)	.67	.53	.25	.58	4	0.472
	22	0.00	.21(X1.0=.21)	.21	.61	.75	.31	4	0.415
22D	0	.88(X.29=.25)	.92(X.71=.65)	.91	.60	.43	.74	4	0.646
	9	.92(X.24=.22)	.92(X.76=.70)	.92	.57	.36	.70	4	0.603
	22	0.00	.20(X1.0=.20)	.20	.66	.75	.56	4	0.485
22P	0	.34(X.75=.26)	.96(X.25=.24)	.50	.51	.36	.67	4	0.498
	9	.34(X.75=.26)	.96(X.25=.24)	.50	.51	.26	.67	4	0.459
	22	0.00	.21(X1.0=.21)	.21	.65	.75	.19	4	0.373
22Q	0	.86(X.65=.56)	.90(X.35=.32)	.88	.58	.38	.62	4	0.589
	9	.68(X.47=.32)	.83(X.53=.51)	.83	.60	.21	.74	4	0.527
	22	.93(X.12=.11)	.64(X.88=.56)	.66	.67	.25	.50	4	0.485
22R	0	.90(X.32=.29)	.98(X.68=.66)	.95	.70	.32	.61	4	0.603
	9	.90(X.30=.27)	.98(X.70=.69)	.96	.71	.32	.61	4	0.604
	22	0.00	.23(X1.0=.23)	.23	.75	0.00	.50	4	0.000

FSS = Forage Size & Spacing
CSS = Cover Size & Spacing
SSI = Size & Spacing Index
RDI = Road Density Index
FVI = Forage Value Index
CVI = Cover Value Index
N = Number of Habitat Variables
HQI = Habitat Quality Index

Figure D-1F

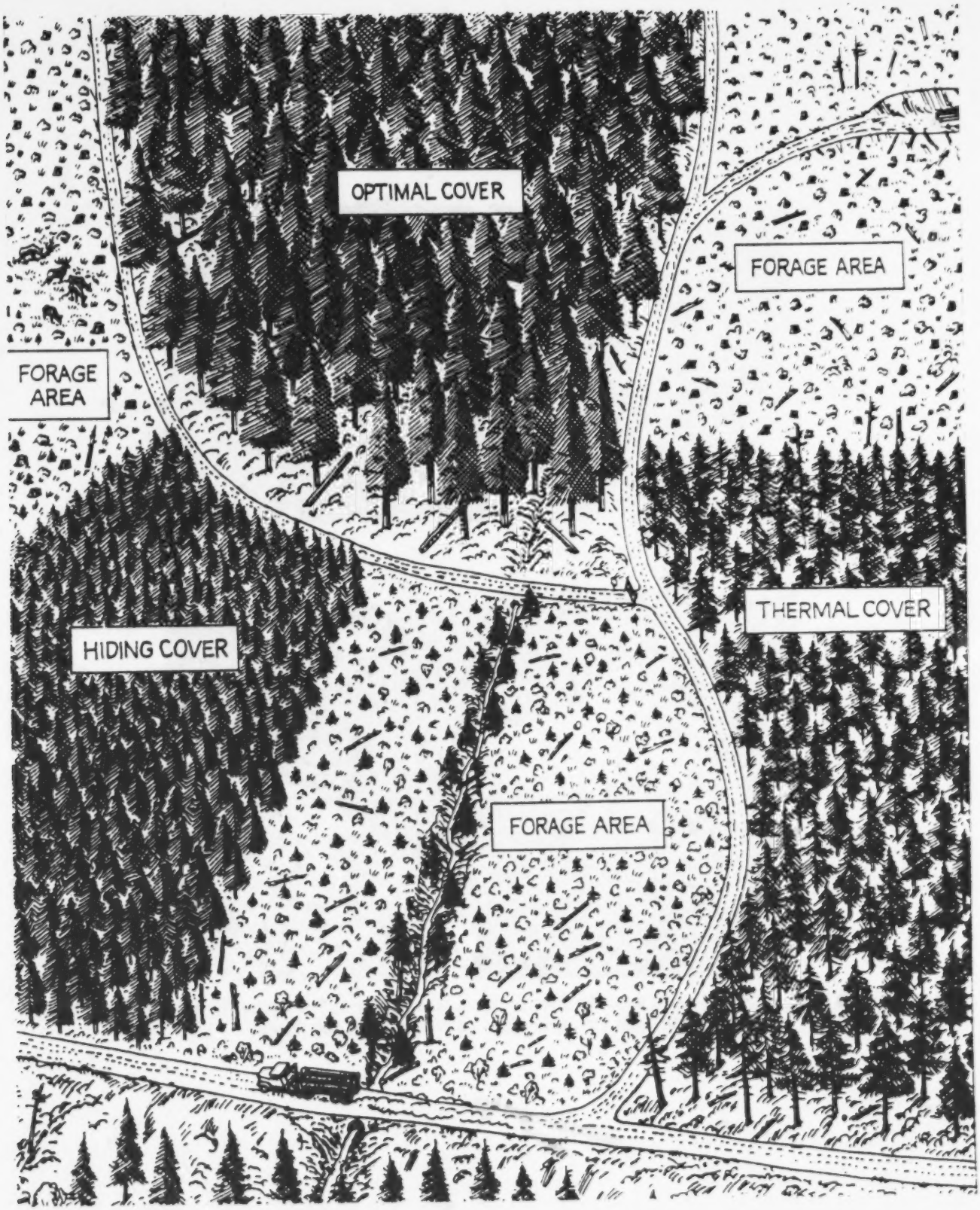


Figure D-2 Landscape view of a managed forest in western Oregon

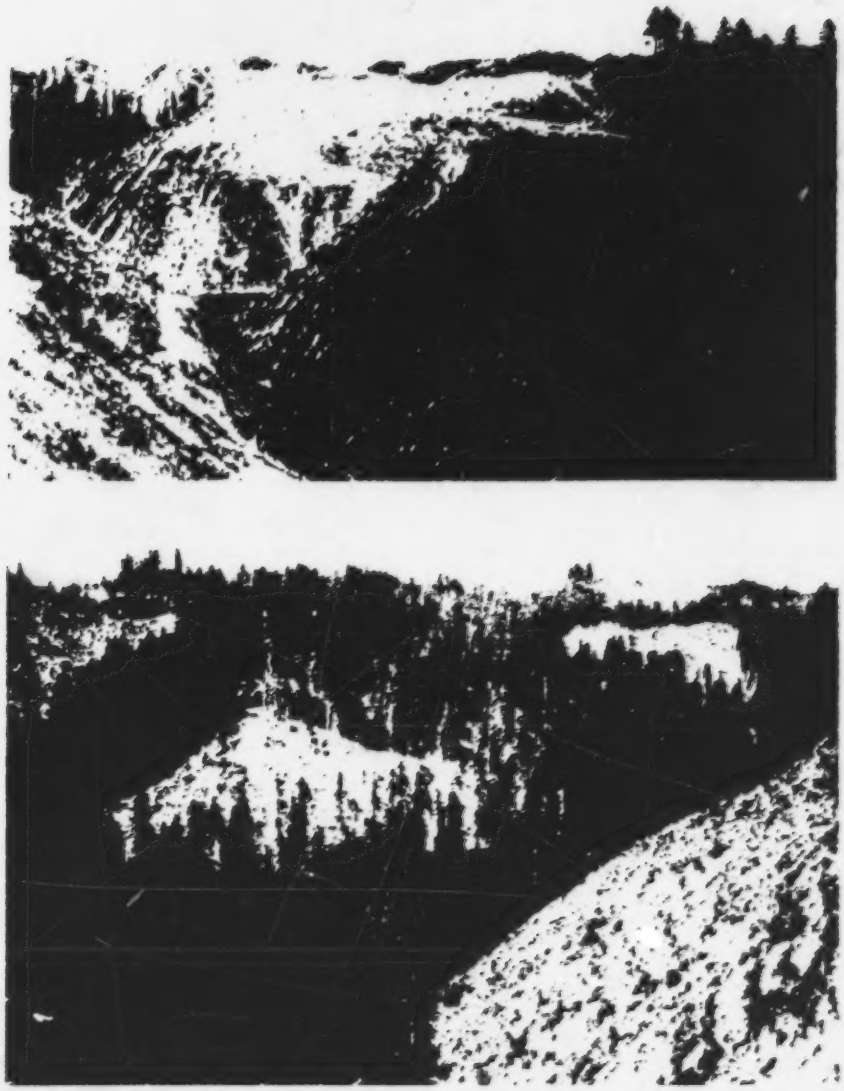


Figure D-3 Forage and cover areas in close proximity to each other. The bottom figure will receive higher use by elk than areas that are father apart as shown in the top figure.

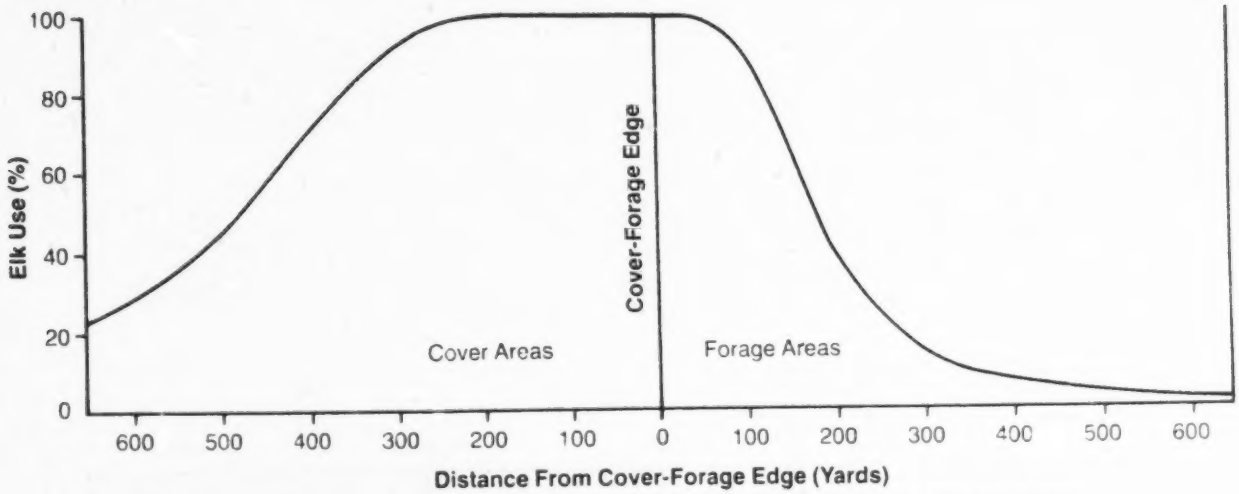


Figure D-4 Distance from cover-forage edge (yards). Relationship of elk use to distance from cover-forage edge (adapted from Figures 8 and 14, Witmer et al. 1985:237-240)

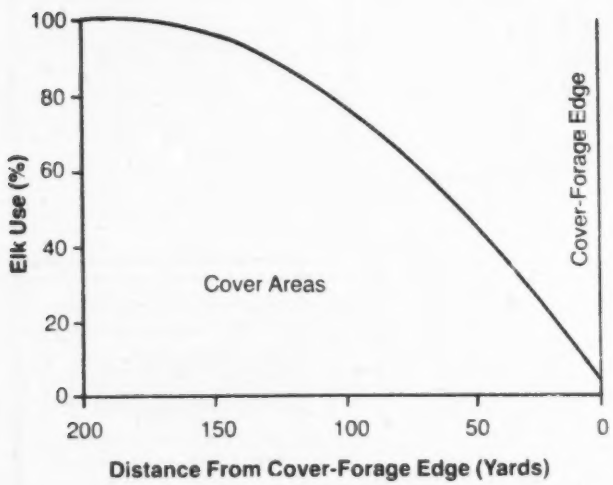


Figure D-5 Distance from cover-forage edge (yards). Relationship of elk use of cover areas to distance from cover-forage edge when cover areas are not large enough to exceed 100 yards from the edge (adapted from Figure 14, Witmer et al. 1985:240)

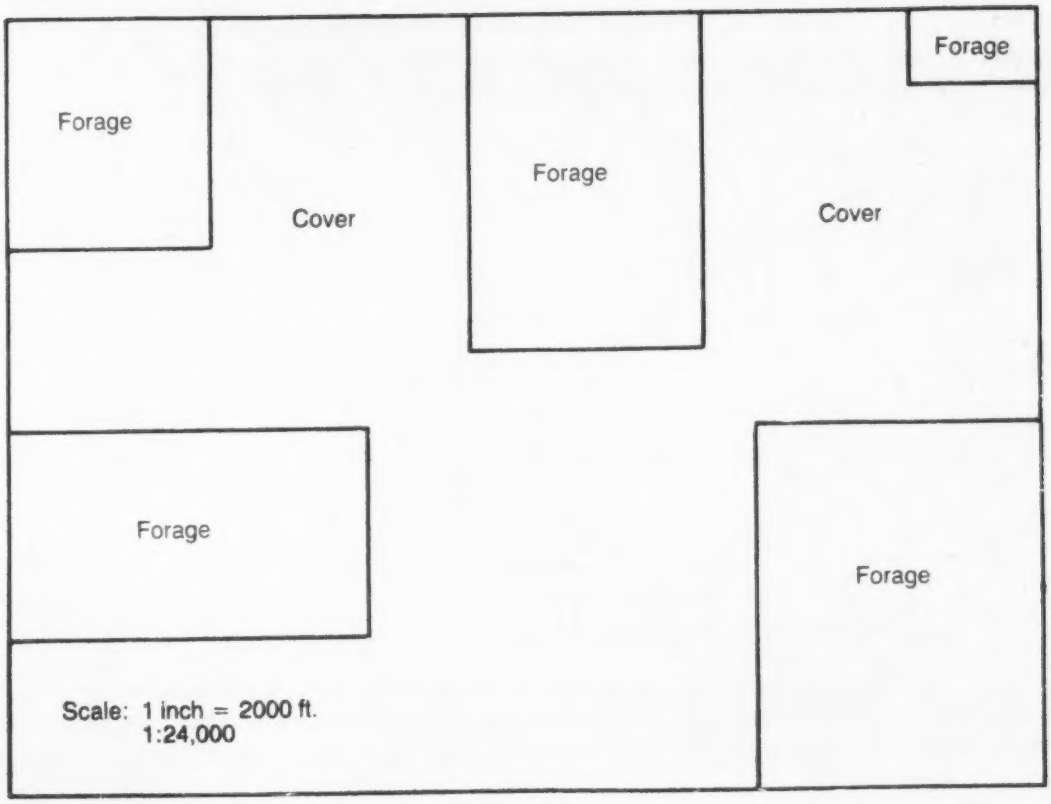


Figure D-6 Identification of forage and cover in the analysis area

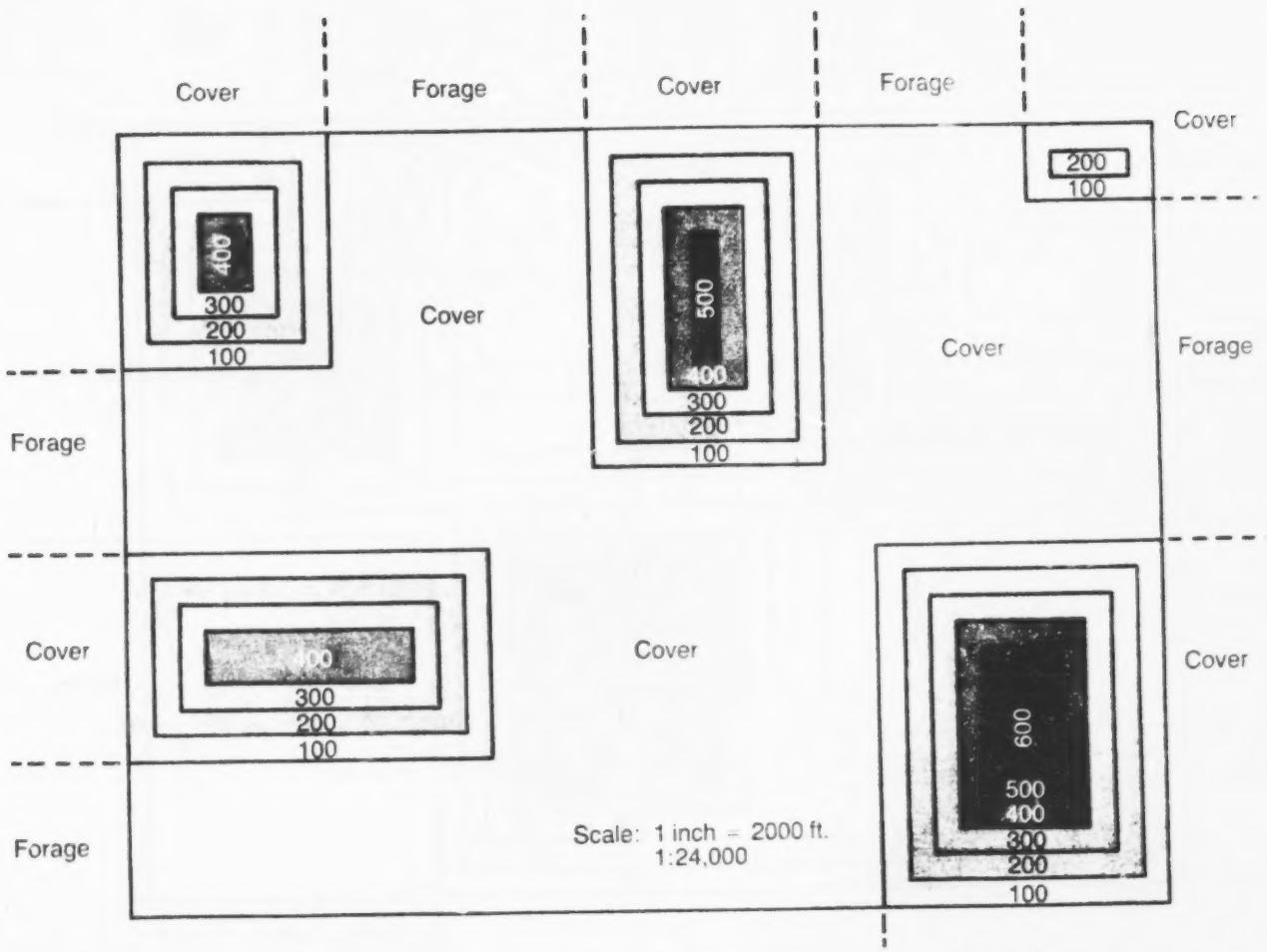


Figure D-7 Delineation of forage areas into 100-yard distance bands away from the edge with cover. Acreage and proportion of area within the bands are shown in Figure D-9.

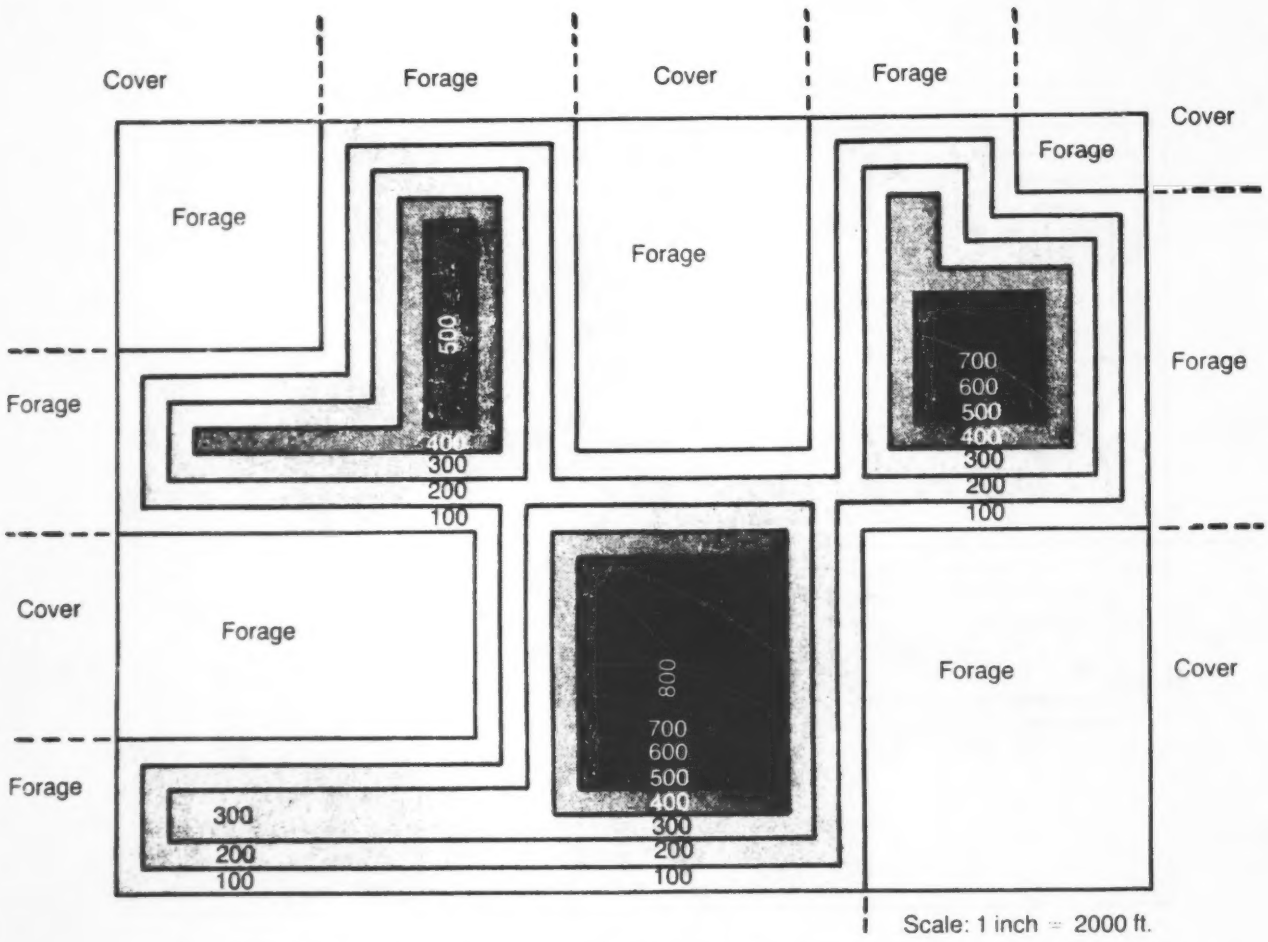


Figure D-8 Delineation of cover areas into 100-yard distance bands away from the edge with forage. Acreage and proportion of area within the bands are shown in Figure D-9.

	Distance from Cover-Forage Edge (Yards)	Percent Use from Figure 3	Rating of Habitat Effectiveness
	> 400	5	0.05
	301 – 400	10	0.10
Forage Area	201 – 300	25	0.25
	101 – 200	70	0.70
Edge	0 – 100	100	1.0
	0 – 300[1]	100	1.0
Cover Area	301 – 400	80	0.80
	401 – 500	60	0.60
	501 – 600	40	0.40
	> 600	20	0.20

[1] *Cover areas not large enough to exceed 100 yards from edge (or 200 yards in width)*

Distance from Cover-Forage Edge (Yards)	Percent Use from Figure 5	Rating of Habitat Effectiveness
0 – 100	50	0.50

Figure D-9 Ratings of habitat effectiveness by 100-yard distance bands away from the cover-forage edge, based on elk use (Figures D-7 and D-8).

WILDLIFE - INTERIOR HABITAT INDEX

SHADY BEACH FIRE RECOVERY PROJECT
OAKRIDGE, OREGON
By
Berntina Steele, Wildlife Biologist

BACKGROUND

The area burned by the Shady Beach fire contained portions of eight subwatersheds. Some of those watersheds had been intensively managed for timber and had limited amounts of mature and old-growth timber remaining in large blocks and in an unfragmented condition. However, some subwatersheds had not been as intensively managed and still retained relatively large blocks of forest habitat with relatively low fragmentation. In some intensively managed subwatersheds there are large blocks of unfragmented forest habitat in portions of the area, but there is no unfragmented forest habitat in the remainder of the subwatershed.

In some portions of the project area interior forest habitat was destroyed by high fire intensities, whereas interior forest habitat blocks elsewhere were affected to a lesser degree or were left unburned.

An index was developed to measure relative changes in potential to provide habitat for interior species (species that select for or that depend upon interior forest conditions for survival or reproduction). This index also provides an opportunity to evaluate relative potential for provision of mature or old-growth forest conditions for purposes not directly related to maintaining forest dependent species (entity values, scenic and recreational values, etc.).

INDEX LIMITATIONS

The index developed to measure relative changes in interior-species habitat potential has limitations.

1. The index measures relative changes in habitat potential based on five major habitat variables. These variables may not be fully compensatory. If indices for the five variables are combined into one overall Interior Habitat Index (IHI), the result is a relative index based on compensation of low variable values by high variable values. Thus two analysis areas, or one analysis area at two different analysis times, may have similar index values but may be quite different in structural habitat quality. To deal with this problem, the index value of each variable will be presented along with the overall Interior Habitat Index.

2. The index provides a relative comparison of values between areas or within an area over time or between alternatives, but the index does not establish a limit for the amount of habitat required.

3. There are some interior habitat patches within subwatersheds which contain a substantial amount of recently harvested land in continuous large tracts. These may have different ecological importance than habitat patches in subwatersheds which contain a variety of stand ages ranging from small, scattered, recently harvested to large old-growth blocks. The index does not address this situation. Interior habitat blocks in proximity to large tracts with substantial harvest will be identified.

Overview of the process

The potential of areas to provide habitat for interior species will vary between areas as a result of past forest management, site types, or fire history. The potential will also vary within an area over time, as forest management is implemented and as older harvest units and stands with fire history develop into mature forest stands.

The index measures relative changes in the potential for provision of habitat for interior species over a 22-year period starting in 1988. The three sets of conditions measured were:

1. Interior habitat available prior to the fire.
2. Interior habitat available after the fire.
3. Interior habitat available after harvest.

The process works as follows:

This list can be used to evaluate analysis area potential and management alternatives for habitat maintenance for interior species and/or old-growth values. A list of variables was developed to reflect the quality of habitat patches.

The list of variables and the system for evaluation of those variables was developed from information provided by researchers specializing in old-growth forest ecosystems and in landscape ecology at Oregon State University in the Forestry Sciences Department. The landscape ecology concept is currently being evaluated as a pilot project on the Blue River Ranger District.

The variables discussed below and the method by which the Shady Beach Recovery Team expects to evaluate relative potential for interior-species management were developed during discussions between Tom Spies and his associates at the Forestry Sciences Laboratory and Ken Kestner and B. T. Steele, Forest Service biologists on the Shady Beach Recovery Project and from information from Brown and others (1985).

The five major variables selected to represent interior-species habitat quality and old-growth values are:

1) **Size of habitat patch.**

   a) At sizes below the minimum level, edge effect has a significant impact on the integrity of the area, and the unaffected interior habitat becomes too small to serve functionally as interior habitat.
   b) At sizes above the minimum level, edge effect has a lower impact on the integrity of the area.
   c) As size increases above the minimum level the amount of edge affected area relative to unaffected interior decreases and the functional ability of the unaffected interior increases.
   d) As the size of the habitat block increases above the minimum allowed, the amount of functional interior habitat increases and the value of the area for interior-species and old-growth values increases.

2) **Edge-to-area ratio.**

a) Habitat patches with edge-to-area ratios above the maximum allowed have a high proportion of their total area under edge effect impacts. Such areas have poor integrity and functional interior habitat is lacking.
b) As edge-to-area ratio decreases below the maximum allowed, less edge affected area and more functional interior habitat is present, and the value of the area for interior species and old growth values increases.

3) **Dominant stand age.**

a) Older age stands are viewed as having more ability to provide habitat components required by a larger diversity of interior forest dependent species.
b) Younger aged stands are generally more homogeneous and have limited ability to provide certain structural habitat components.
c) Some younger stands, created by even-aged timber management, may have no capability of providing structural habitat features required by many interior forest species.
d) Thus older stands (200 to 400 years and older) have higher potential to provide quality interior habitat than younger stands (50 to 120 years of age) and will be rated as superior in value for interior species and old-growth values.

4) **Canopy diversity.**

Stands with multiple-canopy layers provide for habitat needs of a higher diversity of interior, forest-dependent species than stands with fewer canopy layers. Forest stands with three canopy layers will be assigned higher values than stands with two layers, and stands with two layers will be assigned higher values than stands with one layer.

5) **Large woody debris.**

Dead and down large woody material is an important component of forest interior habitats. Large woody debris will be assessed based on relationships between stand age and past management history. The relationship takes into consideration large woody debris present after natural fires, as well as after harvest, decomposition through time, and eventual production and accumulation in older stands. The values that are assigned to various treatment and age combinations are based on recommendations made by old-growth and landscape ecologists at Oregon State University.

The five major habitat variables are affected by changes in the landscape that develop over time, and that result from impacts of the fire and from harvest activity associated with salvage of fire-damaged timber. Changes which are anticipated to affect habitat variables include:

1. Maturation of well-established, fire-history stands.
2. Maturation of well-established, historical harvest areas.
3. Loss of forest stands to high fire-intensity.
4. Loss of forest stands by clearcutting.
5. Increased fragmentation resulting from loss of forest stands by fire, harvesting, or road building.
6. Reduction in canopy closure by light-to-moderate fire intensity.
7. Reduction in canopy layering by light-to-moderate fire intensity.
8. Reduction in canopy closure by partial harvest.
9. Reduction in canopy layering by partial harvest.
10. Loss of forest stands and reduction in canopy closure by road clearing and construction.
11. Recovery of canopy closure by understory regeneration (beyond the scope of this analysis).
12. Recovery of canopy layering by understory regeneration (beyond the scope of this analysis).
13. Reduction in fragmentation by maturation of fire or harvest created openings (beyond the scope of this analysis).
14. Amount of fire damage within a subwatershed may affect amount of salvage volume harvested. Amount of volume harvested by fire salvage may affect amount of volume scheduled to be harvested outside the fire boundary but within the subdrainage. The effect on volume scheduled for harvest outside the fire boundary may affect potential to retain interior habitat blocks within that area.

Each of the five major variables is represented by an index. However, as stated in the Index Limitations section, the variables appear to compensate for each other if combined into one overall index. Thus an overall index may mask deficiencies in structural habitat components. For this reason, the individual indices were displayed along with the overall Interior Habitat Index.

Analysis area and time period

The overall analysis area consists of the aggregation of the boundaries of all subwatersheds that were impacted by the Shady Beach fire. Each subwatershed was analyzed separately as an independent analysis area.

Only Forest Service managed lands located within the project area boundary are included in any areas identified as potential interior species habitat.

The time period selected for analysis was 0 to 22 years. Pre-fire Year 0 represents pre-fire conditions present or planned before the fire. Post-fire Year 0 represents post-fire conditions resulting from the Shady Beach fire. Year 22 represents a future condition in which older harvest stands enter a condition with some potential for interior habitat management.

INDEX PARTS

Variable 1: Minimum patch size

Minimum patch size was used as a primary screening to sort areas with potential for interior-habitat management from areas without such potential. Minimum patch size is modified by edge-to-area ratio. Habitat patches must be 80 acres or larger if they have an edge-to-area ratio of 83 feet per acre. However, patches with edge-to-area ratios between 83 feet per acre and 88 feet per acre must be 112 acres or larger to qualify. These dimensions are based on minimum size needed to maintain a minimum block size of edge unaffected habitat.

Patch size was also be used as a measure of relative value of individual patches. Larger patch sizes indicate a relatively higher value for interior habitat.

For this analysis area, the largest patch of contiguous interior habitat currently available is 1,400 acres in size. Prior to the fire the largest interior habitat available was 2,200 acres. Within the analysis period, the largest interior habitat block that could be expected to develop is approximately 2,500 acres. For minimum size criteria, there are no areas less than 100 acres in size that meet the edge-to-area ratio criteria. For these reasons the size indices run from 0.1 for 100 acres to 1.0 for 2,500 acres or larger for this analysis area. The scale shown in Figure E-1 is for use in making relative comparisons, and is not a measure of viability for all interior species.

Acres	Value	Acres	Value	Acres	Value
100-200	.05	1001-1100	.43	1801-1900	.76
210-300	.10	1101-1200	.47	1901-2000	.80
301-400	.13	1201-1300	.51	2001-2100	.84
401-500	.18	1301-1400	.55	2101-2200	.88
501-600	.22	1401-1500	.59	2201-2300	.94
601-700	.26	1501-1600	.63	2301-2400	.96
701-800	.30	1601-1700	.67	2401-2500	.98
801-900	.34	1701-1800	.72	>2500	1.00
901-1000	.38				

Figure E-1 Minimum patch size comparisons

Variable 2: Edge-to-area ratio

Edge-to-area ratio was used as a primary screening to sort areas with potential for interior habitat management from areas without such potential. Edge-to-area ratio must not exceed 88 feet per acre. Patches with higher edge-to-area ratios are primarily edge habitat, and do not satisfy the needs of interior species.

Edge-to-area ratio was also be used as a measure of relative value of individual patches. The lower the edge-to-area ratio, the higher the relative value for interior habitat.

Given a maximum expected size of 2,500 acres, the minimum possible edge-to-area ratio is 15 feet per acre. The maximum acceptable edge-to-area ratio is 88 feet per acre. Thus the scale of values shown in Figure E-2 for edge-to-area ratio runs from 1.0 for 15 feet per acre to 0.10 for 88 feet per acre.

Edge/Area	Value	Edge/Area	Value	Edge/Area	Value
15-19	1.00	40-44	.69	65-69	.37
20-24	.94	45-49	.63	70-74	.31
25-29	.88	50-54	.56	75-79	.25
30-34	.82	55-59	.50	80-84	.18
35-39	.75	60-64	.44	85-88	.10

Figure E-2 Edge-to-area ratio

Variable 3: Dominant age

Dominant age of stands within habitat patches was used to evaluate relative value of the habitat patch for interior species. Valuation was based on acreage within each patch in the following categories and is shown in Figure E-3.

Dominant Age	Value	Dominant Age	Value	Dominant Age	Value
50 - 80 yr	0.1	141 - 200 yr	0.7	301 - 400 yr	0.9
81 - 100 yr	0.3	201 - 300 yr	0.8	401 + yr	1.0
101 - 140 yr	0.5				

Figure E-3 Dominant age valuation

Variable 4: Canopy Diversity

Canopy diversity of stands within habitat patches was used to evaluate relative value of the habitat patch for interior species. Valuation (shown in Figure E-4) was based on acreage within each patch in the following categories.

Canopy Layer	Value
1	0.1
2	0.6
3	1.0

Figure E-4 Canopy layer value

The majority of stands with predicted mortality (PM) classes in Layer 1 of G, 0, 1, or 2 generally retained some portion of their secondary canopy. Classes of 3 or 4 generally lost all of their secondary canopy. Classes 5 to 9 were reduced to open-timber stands. Given these facts, the following assumptions were made in predicting Interior Habitat Indices:

All stands exceeding 50 years of age and with PM class of G in Layer 1 were considered for Interior Habitat Index analysis. They were assumed to have retained Layers 2 and 3, if they originally had such layers.

All stands exceeding 50 years of age and with PM class of 0, 1, or 2 in Layer 1 were considered for Interior Habitat Index analysis. They were assumed to have retained at least a portion of Layer 2, but not Layer 3, if they originally had such layers.

All stands exceeding 50 years of age and with PM class of 3 or 4 in Layer 1 were considered marginally acceptable for Interior Habitat Index analysis. They were assumed to have lost Layers 2 and 3, if they originally had such layers.

All stands less than 50 years of age, or exceeding 50 years of age, but with PM class of 5 to 9 in Layer 1 were considered to be unacceptable for Interior Habitat Index analysis.

Variable 5: Large Woody Debris

Large woody debris of stands within habitat patches were estimated, based on age and treatment history. The minimum age considered in this analysis is 50 years. Values shown in Figure E-5 are assigned as follows:

Treatment and Age	Value
50-100 year harvested area	0.1
50-99 year stand, no harvest	0.6
100-149 year stand, no harvest	0.4
150-199 year stand, no harvest	0.5
200-249 year stand, no harvest	0.6
250-299 year stand, no harvest	0.7
300-349 year stand, no harvest	0.8
350-399 year stand, no harvest	0.9
400+ year stand, no harvest	1.0

Figure E-5 Large woody debris value

Calculation of Interior-Habitat Index

A number of potential relationships can exist between habitat variables in a multivariate evaluation model. To obtain one index of relative value, all variables must be integrated to explain the expected relationships between a wide variety of habitat conditions.

The interactions between habitat patch size, edge-to-area ratio, dominant age, canopy diversity, and large woody debris appear to be partially but not fully compensatory. A high score in one variable does not fully compensate for a low score in another variable. A geometric mean is applicable when variables do not fully compensate for each other.

The equation for integrating habitat variables to derive an Interior Habitat Index via the geometric mean is as follows:

$$\text{Interior Habitat Index} = (PS \times EA \times DA \times CD \times LWD)^{1/N}$$

where: PS = Patch Size Index
EA = Edge to Area Index
DA = Dominant Age Index
CD = Canopy Diversity Index
LWD = Large Woody Debris Index
1/N = Nth root of the product taken to obtain the geometric mean
where: N = the number of habitat variables

Interpretation of the Results:

The Interior Habitat Index derived from the equation in the previous section can be used to provide a relative comparison of capability of areas to provide habitat for interior species. The analysis can be used to evaluate relative differences between different potential habitat patches, or to evaluate relative differences within a potential habitat patch, over time, or under management.

Each of the five variable indices should also be considered when making management decisions as the overall index could partially mask habitat characteristics which may be important for certain management objectives. For example, old-growth values will be highlighted by indices for Variables 3, 4, and 5. But the overall index could be moderated by indices for Variables 1 and 2.

IHI Pre-fire

For the purpose of comparison, the relative value of each habitat patch in the pre-fire condition is presented in Figure E-6.

ID#	ACRES	E/A	GE	CANOPY
A	204ac	74ft/ac	150-160 yr	2-3 cr
B	230ac	58ft/ac	150 yr	3 cr
C	437ac	59ft/ac	150-300 yr	1-3 cr
D	970ac	29ft/ac	150-200 yr	1-2 cr
E	552ac	49ft/ac	120-200 yr	1-2 cr
F	472ac	78ft/ac	150 yr	2 cr
H	670ac	80ft/ac	150-200 yr	2 cr
I	192ac	79ft/ac	120-200 yr	1-2 cr
J	549ac	63ft/ac	50-250 yr	1-2 cr
I/J	741ac	64ft/ac	50-250	1-2 cr
K	472ac	71ft/ac	150-200 yr	1-2 cr
L	171ac	8ft/ac	80-250 yr	1-3 cr
M	246ac	3ft/ac	150 yr	2-3 cr
N	1057ac	39ft/ac	70-250 yr	1-3 cr
O	505ac	31ft/ac	150-250 yr	2-3 cr
P	210ac	85ft/ac	150-250 yr	2-3 cr
O/P	715ac	78ft/ac	150-250 yr	2-3 cr
Q	824ac	32ft/ac	80-250 yr	1-3 cr
R	514ac	47ft/ac	120-250 yr	2 cr
S	416ac	52ft/ac	120-250 yr	2 cr
R-S	971ac	45ft/ac	120-250 yr	2 cr
T	350ac	69ft/ac	150-200 yr	1-2 cr
U	396ac	34ft/ac	80-250 yr	1-3 cr

Figure E-6 IHI pre-fire

Data for I/J, O/P, and R/S are for combined habitat patches. Habitat Patches Q, T, and U were heavily impacted by the fire and are not viable under any alternative.

The total amount of interior habitat available within the project area for before the fire was 8,691 acres. Nineteen habitat patches were viable before the Shady Beach fire occurred.

The relative values of each of the habitat blocks considered for Interior Habitat Index analysis before the fire are shown in Figure E-7.

ID#	SIZE(ac)	ACRE	E/A	AGE	CANOPY	LWD	IHI	OPPORTUNITIES
A	204	0.10	0.31	0.70	0.92	0.50	0.40	-0-
B	230	0.10	0.50	0.70	1.00	0.50	0.45	BEMA,SOHA
C	437	0.18	0.50	0.72	0.64	0.56	0.47	PWHA, SOHA
D	970	0.38	0.88	0.71	0.56	0.58	0.60	PWHA, SOHA
E	552	0.22	0.63	0.78	0.53	0.58	0.43	SOHA
F	472	0.05	0.25	0.68	0.60	0.51	0.30	-0-
H	670	0.05	0.18	0.74	0.62	0.54	0.29	-0-
I	192	0.05	0.25	0.68	0.37	0.51	0.28	-0-
J	549	0.22	0.44	0.48	0.53	0.55	0.42	MHA
I/J	741	0.30	0.44	0.62	0.49	0.54	0.46	-0-
K	472	0.18	0.31	0.61	0.43	0.60	0.39	-0-
L	171	0.26	0.75	0.58	0.50	0.59	0.51	-0-
M	246	0.10	0.31	0.50	0.63	0.50	0.34	MHA
N	1057	0.43	0.75	0.55	0.68	0.50	0.57	-0-
O	505	0.22	0.82	0.77	0.83	0.63	0.59	MHA
P	210	0.10	0.10	0.71	0.88	0.65	0.33	MHA
O/P	715	0.18	0.37	0.77	0.85	0.64	0.49	-0-
Q	824	0.34	0.82	0.71	0.94	0.58	0.64	SOHA
R	514	0.22	0.63	0.61	0.60	0.53	0.49	-0-
S	416	0.18	0.56	0.65	0.60	0.49	0.45	-0-
R/S	971	0.38	0.63	0.64	0.60	0.51	0.54	-0-
T	350	0.13	0.37	0.66	0.61	0.52	0.40	-0-
U	396	0.13	0.82	0.70	0.38	0.56	0.44	-0-

Figure E-7 IHI relative values

An overall index value for habitat quality under pre-fire conditions is 0.41. This figure represents the relative quality of the 8,691 acres of interior habitat remaining before the Shady Beach fire.

IHI ALTERNATIVE E - NO ACTION

Under the No Action Alternative, Alternative E, the relative value of each habitat patch can be presented as follows in Figure E-8.

ID#	ACRES	E/A	AGE	CANOPY	FIRE
A	204ac	74ft/ac	150-160 yr	2-3 cr	NFI
B	230ac	58ft/ac	150 yr	3 cr	NFI
C	395ac	63ft/ac	150-300 yr	1-3 cr	PFI
D	369ac	46ft/ac	150-200 yr	1-2 cr	PFI
E	497ac	46ft/ac	120-200 yr	1-2 cr	PFI
F	177ac	78ft/ac	150 yr	2 cr	NFI
H	191ac	80ft/ac	150-200 yr	2 cr	PFI
I	192ac	79ft/ac	120-200 yr	1-2 cr	NFI
J	549ac	63ft/ac	50-250 yr	1-2 cr	NFI
I/J	741ac	64ft/ac	50-250	1-2 cr	NFI
K	181ac	87ft/ac	150-200 yr	1-2 cr	NFI
L	171ac	88ft/ac	80-250 yr	1-3 cr	PFI
M	246ac	73ft/ac	150 yr	2-3 cr	NFI
N	879ac	44ft/ac	70-250 yr	1-3 cr	PFI
O	280ac	64ft/ac	150-250 yr	2-3 cr	PFI
P	210ac	85ft/ac	150-250 yr	2-3 cr	NFI
O/P	490ac	78ft/ac	150-250 yr	2-3 cr	PFI
R	514ac	47ft/ac	120-250 yr	2 cr	NFI
S	416ac	52ft/ac	120-250 yr	2 cr	NFI
R-S	971ac	45ft/ac	120-250 yr	2 cr	NFI

Figure E-8 Alternative E habitat patch value

Where NFI = no fire impacts, PFI = partial fire impacts.
Data for I/J, O/P, and R/S are for combined habitat patches.

The total amount of interior habitat available within the project area under the No Action Alternative is 5,701 acres. Sixteen habitat patches remain viable under this alternative.

Given that the majority of stands with predicted mortality (PM) classes in Layer 1 of G, 0, 1, or 2, generally retained some portion of their secondary canopy, classes of 3 or 4 generally lost all of their secondary canopy, and classes 5 to 9 were reduced to open timber stands, the following assumptions were made in predicting Interior Habitat Indices:

All stands exceeding 50 years of age and with PM class of G in Layer 1 were considered for Interior Habitat Index analysis, and were assumed to have retained Layers 2 and 3, if they originally had such layers.

All stands exceeding 50 years of age and with PM class of 0, 1, or 2 in Layer 1 were considered for Interior Habitat Index analysis, and were assumed to have retained at least a portion of Layer 2, but not Layer 3, if they originally had such layers.

All stands exceeding 50 years of age and with PM class of 3 or 4 in Layer 1 were considered marginally acceptable for Interior Habitat Index analysis, and were assumed to have lost Layers 2 and 3, if they originally had such layers.

All stands less than 50 years of age, or exceeding 50 years of age, but with PM class of 5 to 9 in Layer 1 were considered to be unacceptable for Interior Habitat Index analysis.

Interior Habitat Indices were determined for each habitat block by combining values for attributes of different stands occurring within the same habitat block.

The relative values of each of the habitat blocks considered for Interior Habitat Index analysis under the No Action Alternative, Alternative E, are shown in Figure E-9.

ID#	SIZE(ac)	ACRE	E/A	AGE	CANOPY	LWD	IHI	ALLOCATION
A	204	0.10	0.31	0.70	0.92	0.50	0.40	-0-
B	230	0.10	0.50	0.70	1.00	0.50	0.45	BEMA
C	395	0.13	0.44	0.72	0.64	0.56	0.43	PWHA,SOHA
D	369	0.18	0.63	0.71	0.54	0.60	0.45	PWHA,SOHA
E	497	0.18	0.63	0.78	0.53	0.58	0.49	SOHA
F	177	0.05	0.25	0.68	0.60	0.51	0.30	-0-
H	191	0.05	0.18	0.74	0.62	0.54	0.29	-0-
I	192	0.05	0.25	0.68	0.37	0.51	0.28	-0-
J	549	0.22	0.44	0.48	0.53	0.55	0.42	MHA
I/J	741	0.30	0.44	0.62	0.49	0.54	0.46	MHA
K	181	0.05	0.10	0.55	0.47	0.59	0.24	-0-
L	171	0.05	0.10	0.73	0.34	0.58	0.27	-0-
M	246	0.10	0.31	0.50	0.63	0.50	0.34	MHA
N	879	0.34	0.69	0.56	0.67	0.50	0.54	-0-
O	280	0.10	0.44	0.77	0.82	0.64	0.45	MHA
P	210	0.10	0.10	0.71	0.88	0.65	0.33	MHA
O/P	490	0.18	0.25	0.77	0.85	0.64	0.45	MHA
R	514	0.22	0.63	0.61	0.60	0.53	0.49	-0-
S	416	0.18	0.56	0.65	0.60	0.49	0.45	-0-
R/S	971	0.38	0.63	0.64	0.60	0.51	0.54	-0-

Figure E-9 Alternative E IHI values

An overall index value for habitat quality under this alternative is 0.41. This figure represents the relative quality of the 5,701 acres of interior habitat remaining under this alternative.

IHI ALTERNATIVE B

Under implementation of Alternative B, the relative value of each habitat patch is shown in Figure E-10.

ID#	ACRES	E/A	AGE	CANOPY	FIRE
A	204ac	74ft/ac	150-160 yr	2-3 cr	NFI
B	230ac	58ft/ac	150 yr	3 cr	NFI
C	284ac	63ft/ac	150-300 yr	1-3 cr	PFI
E	164ac	46ft/ac	120-200 yr	1-2 cr	PFI
F	177ac	78ft/ac	150 yr	2 cr	NFI
I	192ac	79ft/ac	120-200 yr	1-2 cr	NFI
J	549ac	63ft/ac	50-250 yr	1-2 cr	NFI
I/J	741ac	64ft/ac	50-250	1-2 cr	NFI
K	153ac	87ft/ac	150-200 yr	1-2 cr	NFI
M	196ac	73ft/ac	150 yr	2-3 cr	NFI
N	784ac	44ft/ac	70-250 yr	1-3 cr	PFI
O	149ac	64ft/ac	150-250 yr	2-3 cr	PFI
P	210ac	85ft/ac	150-250 yr	2-3 cr	NFI
O/P	359ac	78ft/ac	150-250 yr	2-3 cr	PFI
R	514ac	47ft/ac	120-250 yr	2 cr	NFI
S	416ac	52ft/ac	120-250 yr	2 cr	NFI
R/S	971ac	45ft/ac	120-250 yr	2 cr	NFI

Figure E-10 Alternative B habitat patch value

Where NFI = no fire impacts, PFI = partial fire impacts.
Data for I/J, O/P, and R/S are for combined habitat patches.

The total amount of interior habitat available within the project area for Alternative B is 4,222 acres. Habitat patches D, H, and L become nonviable under this alternative.

Given that the majority of stands with predicted mortality (PM) classes in Layer 1 of G, 0, 1, or 2, generally retained some portion of their secondary canopy, classes of 3 or 4 generally lost all of their secondary canopy and classes 5 to 9 were reduced to open timber stands, the following assumptions were made in predicting Interior Habitat Indices:

All stands exceeding 50 years of age and with PM class of G in Layer 1 were considered for Interior Habitat Index analysis, and were assumed to have retained Layers 2 and 3, if they originally had such layers.

All stands exceeding 50 years of age and with PM class of 0, 1, or 2 in Layer 1 were considered for Interior Habitat Index analysis, and were assumed to have retained at least a portion of Layer 2, but not Layer 3, if they originally had such layers.

All stands exceeding 50 years of age and with PM class of 3 or 4 in Layer 1 were considered marginally acceptable for Interior Habitat Index analysis, and were assumed to have lost Layers 2 and 3, if they originally had such layers.

All stands less than 50 years of age, or exceeding 50 years of age, but with PM class of 5 to 9 in Layer 1 were considered to be unacceptable for Interior Habitat Index analysis.

Interior Habitat Indices were determined for each habitat block by combining values for attributes of different stands occurring within the same habitat block.

The relative values of each of the habitat blocks considered for Interior Habitat Index analysis under Alternative B are shown in Figure E-11.

ID#	SIZE(ac)	ACRE	E/A	AGE	CANOPY	LWD	IHI	ALLOCATION
A	204	0.10	0.31	0.70	0.92	0.50	0.40	-0-
B	230	0.10	0.50	0.70	1.00	0.50	0.45	BEMA
C	284	0.10	0.37	0.72	0.64	0.56	0.39	-0-
E	164	0.05	0.31	0.78	0.53	0.58	0.35	-0-
F	177	0.05	0.25	0.68	0.60	0.51	0.30	-0-
I	192	0.05	0.25	0.68	0.37	0.51	0.28	-0-
J	549	0.22	0.44	0.48	0.53	0.55	0.42	-0-
I/J	741	0.30	0.44	0.62	0.49	0.54	0.46	-0-
K	153	0.05	0.10	0.55	0.47	0.59	0.24	-0-
M	196	0.05	0.25	0.50	0.63	0.50	0.29	-0-
N	784	0.30	0.75	0.56	0.67	0.50	0.53	-0-
O	149	0.05	0.18	0.77	0.82	0.64	0.33	-0-
P	210	0.10	0.10	0.71	0.88	0.65	0.33	-0-
O/P	359	0.13	0.25	0.77	0.85	0.64	0.44	-0-
R	514	0.22	0.63	0.61	0.60	0.53	0.49	-0-
S	416	0.18	0.56	0.65	0.60	0.49	0.45	-0-
R/S	971	0.38	0.63	0.64	0.60	0.51	0.54	-0-

Figure E-11 Alternative B IHI values

An overall index for habitat quality under this alternative is 0.40. This figure represents the relative quality of the 4,222 acres of interior habitat remaining under this alternative.

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IHI ALTERNATIVE C

Under implementation of Alternative C, the relative value of each habitat patch is presented in Figure E-12.

ID#	ACRES	E/A	AGE	CANOPY	FIRE
A	204ac	74ft/ac	150-160 yr	2-3 cr	NFI
B	230ac	58ft/ac	150 yr	3 cr	NFI
C	284ac	63ft/ac	150-300 yr	1-3 cr	PFI
E	164ac	46ft/ac	120-200 yr	1-2 cr	PFI
F	177ac	78ft/ac	150 yr	2 cr	NFI
I	192ac	79ft/ac	120-200 yr	1-2 cr	NFI
J	549ac	63ft/ac	50-250 yr	1-2 cr	NFI
I/J	741ac	64ft/ac	50-250	1-2 cr	NFI
K	153ac	87ft/ac	150-200 yr	1-2 cr	NFI
M	196ac	73ft/ac	150 yr	2-3 cr	NFI
N	784ac	44ft/ac	70-250 yr	1-3 cr	PFI
O	149ac	64ft/ac	150-250 yr	2-3 cr	PFI
P	210ac	85ft/ac	150-250 yr	2-3 cr	NFI
O/P	359ac	78ft/ac	150-250 yr	2-3 cr	PFI
R	514ac	47ft/ac	120-250 yr	2 cr	NFI
S	416ac	52ft/ac	120-250 yr	2 cr	NFI
R/S	971ac	45ft/ac	120-250 yr	2 cr	NFI

Figure E-12 Alternative C habitat patch value

Where NFI = no fire impacts, PFI = partial fire impacts.
Data for I/J, O/P, and R/S are for combined habitat patches.

The total amount of interior habitat available within the project area for Alternative B is 4,222 acres. Habitat patches D, H, and L become nonviable under this alternative.

Given that the majority of stands with predicted mortality classes in Layer 1 of G, 0, 1, or 2, generally retained some portion of their secondary canopy, classes of 3 or 4 generally lost all of their secondary canopy and classes 5 to 9 were reduced to open timber stands, the following assumptions were made in predicting Interior Habitat Indices:

All stands exceeding 50 years of age and with PM class of G in Layer 1 were considered for Interior Habitat Index analysis, and were assumed to have retained Layers 2 and 3, if they originally had such layers.

All stands exceeding 50 years of age and with PM class of 0, 1, or 2 in Layer 1 were considered for Interior Habitat Index analysis, and were assumed to have retained at least a portion of Layer 2, but not Layer 3, if they originally had such layers.

All stands exceeding 50 years of age and with PM class of 3 or 4 in Layer 1 were considered marginally acceptable for Interior Habitat Index analysis, and were assumed to have lost Layers 2 and 3, if they originally had such layers.

All stands less than 50 years of age, or exceeding 50 years of age, but with PM class of 5 to 9 in Layer 1 were considered to be unacceptable for Interior Habitat Index analysis.

Interior Habitat Indices were determined for each habitat block by combining values for attributes of different stands occurring within the same habitat block.

The relative values of each of the habitat blocks considered for Interior Habitat Index analysis under Alternative C are shown in Figure E-13.

ID#	SIZE(ac)	ACRE	E/A	AGE	CANOPY	LWD	IHI	ALLOCATION
A	204	0.10	0.31	0.70	0.92	0.50	0.40	-0-
B	230	0.10	0.50	0.70	1.00	0.50	0.45	BEMA
C	284	0.10	0.37	0.72	0.64	0.56	0.39	PWHA
E	164	0.05	0.31	0.78	0.53	0.58	0.35	PWHA
F	177	0.05	0.25	0.68	0.60	0.51	0.30	-0-
I	192	0.05	0.25	0.68	0.37	0.51	0.28	-0-
J	549	0.22	0.44	0.48	0.53	0.55	0.42	-0-
I/J	741	0.30	0.44	0.62	0.49	0.54	0.46	-0-
K	153	0.05	0.10	0.55	0.47	0.59	0.24	-0-
M	196	0.05	0.25	0.50	0.63	0.50	0.29	-0-
N	784	0.30	0.75	0.56	0.67	0.50	0.53	-0-
O	149	0.05	0.18	0.77	0.82	0.64	0.33	-0-
P	210	0.10	0.10	0.71	0.88	0.65	0.33	-0-
O/P	359	0.13	0.25	0.77	0.85	0.64	0.44	-0-
R	514	0.22	0.63	0.61	0.60	0.53	0.49	-0-
S	416	0.18	0.56	0.65	0.60	0.49	0.45	-0-
R/S	971	0.38	0.63	0.64	0.60	0.51	0.54	-0-

Figure E-13 Alternative C IHI values

An overall index value for habitat quality under this alternative is 0.40. This value represents the relative quality of the 4,222 acres of interior habitat remaining under this alternative.

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IHI ALTERNATIVE D

Under implementation of Alternative D, the relative value of each habitat patch is presented in Figure E-14.

ID#	ACRES	E/A	AGE	CANOPY	FIRE
A	204ac	74ft/ac	150-160 yr	2-3 cr	NFI
B	230ac	58ft/ac	150 yr	3 cr	NFI
C	284ac	63ft/ac	150-300 yr	1-3 cr	PFI
E	193ac	46ft/ac	120-200 yr	1-2 cr	PFI
F	177ac	78ft/ac	150 yr	2 cr	NFI
I	192ac	79ft/ac	120-200 yr	1-2 cr	NFI
J	549ac	63ft/ac	50-250 yr	1-2 cr	NFI
I/J	741ac	64ft/ac	50-250	1-2 cr	NFI
K	153ac	87ft/ac	150-200 yr	1-2 cr	NFI
M	196ac	73ft/ac	150 yr	2-3 cr	NFI
N	784ac	44ft/ac	70-250 yr	1-3 cr	PFI
O	149ac	64ft/ac	150-250 yr	2-3 cr	PFI
P	210ac	85ft/ac	150-250 yr	2-3 cr	NFI
O/P	359ac	78ft/ac	150-250 yr	2-3 cr	PFI
R	514ac	47ft/ac	120-250 yr	2 cr	NFI
S	416ac	52ft/ac	120-250 yr	2 cr	NFI
R-S	971ac	45ft/ac	120-250 yr	2 cr	NFI

Figure E-14 Alternative D habitat patch values

Where NFI = no fire impacts, PFI = partial fire impacts.
Data for patch I/J, O/P, and R/S is for combined habitat patches.

Under implementation of Alternative D, 4,251 acres of interior habitat will remain in the project area.

Given that the majority of stands with predicted mortality classes in Layer 1 of G, 0, 1, or 2, generally retained some portion of their secondary canopy, classes of 3 or 4 generally lost all of their secondary canopy and classes 5 to 9 were reduced to open timber stands, the following assumptions were made in predicting Interior Habitat Indices:

All stands exceeding 50 years of age and with PM class of G in Layer 1 were considered for Interior Habitat Index analysis, and were assumed to have retained Layers 2 and 3, if they originally had such layers.

All stands exceeding 50 years of age and with PM class of 0, 1, or 2 in Layer 1 were considered for Interior Habitat Index analysis, and were assumed to have retained at least a portion of Layer 2, but not Layer 3, if they originally had such layers.

All stands exceeding 50 years of age and with PM class of 3 or 4 in Layer 1 were considered marginally acceptable for Interior Habitat Index analysis, and were assumed to have lost Layers 2 and 3, if they originally had such layers.

All stands less than 50 years of age, or exceeding 50 years of age, but with PM class of 5 to 9 in Layer 1 were considered to be unacceptable for Interior Habitat Index analysis.

Interior Habitat Indices were determined for each habitat block by combining values for attributes of different stands occurring within the same habitat block.

The relative values of each of the habitat blocks considered for Interior Habitat Index analysis under Alternative D are shown in Figure E-15.

ID#	SIZE(ac)	ACRE	E/A	AGE	CANOPY	LWD	IHI	ALLOCATION
A	204	0.10	0.31	0.70	0.92	0.50	0.4	0-0-
B	230	0.10	0.50	0.70	1.00	0.50	0.4	5BEMA
C	284	0.10	0.37	0.72	0.64	0.56	0.3	9-0-
E	193	0.05	0.31	0.78	0.53	0.58	0.3	3-0-
F	177	0.05	0.25	0.68	0.60	0.51	0.3	0-0-
I	192	0.05	0.25	0.68	0.37	0.51	0.2	8-0-
J	549	0.22	0.44	0.48	0.53	0.55	0.4	2-0-
I/J	741	0.30	0.44	0.62	0.49	0.54	0.4	6-0-
K	153	0.05	0.10	0.55	0.47	0.59	0.2	4-0-
M	196	0.05	0.25	0.50	0.63	0.50	0.2	9-0-
N	784	0.30	0.75	0.56	0.67	0.50	0.5	3-0-
O	149	0.05	0.18	0.77	0.82	0.64	0.3	3-0-
P	210	0.10	0.10	0.71	0.88	0.65	0.3	3-0-
O/P	490	0.13	0.25	0.77	0.85	0.64	0.4	4-0-
R	514	0.22	0.63	0.61	0.60	0.53	0.4	9-0-
S	416	0.18	0.56	0.65	0.60	0.49	0.4	5-0-
R/S	971	0.38	0.63	0.64	0.60	0.51	0.5	4-0-

Figure E-15 Alternative D IHI values

An overall index value for habitat quality under this alternative is 0.40. This figure represents the relative quality of the 4,251 acres of interior habitat remaining under this alternative.

IHI ALTERNATIVE F

Under implementation of Alternative F, the relative value of each habitat patch are shown in Figure E-16.

ID#	ACRES	E/A	AGE	CANOPY	FIRE
A	204ac	74ft/ac	150-160 yr	2-3 cr	NFI
B	230ac	58ft/ac	150 yr	3 cr	NFI
C	395ac	63ft/ac	150-300 yr	1-3 cr	PFI
D	369ac	46ft/ac	150-200 yr	1-2 cr	PFI
E	497ac	46ft/ac	120-200 yr	1-2 cr	PFI
F	177ac	78ft/ac	150 yr	2 cr	NFI
H	191ac	80ft/ac	150-200 yr	2 cr	PFI
I	192ac	79ft/ac	120-200 yr	1-2 cr	NFI
J	549ac	63ft/ac	50-250 yr	1-2 cr	NFI
I/J	741ac	64ft/ac	50-250	1-2 cr	NFI
K	181ac	87ft/ac	150-200 yr	1-2 cr	NFI
L	171ac	88ft/ac	80-250 yr	1-3 cr	PFI
M	246ac	73ft/ac	150 yr	2-3 cr	NFI
N	844ac	44ft/ac	70-250 yr	1-3 cr	PFI
O	274ac	64ft/ac	150-250 yr	2-3 cr	PFI
P	210ac	85ft/ac	150-250 yr	2-3 cr	NFI
O/P	484ac	78ft/ac	150-250 yr	2-3 cr	PFI
R	514ac	47ft/ac	120-250 yr	2 cr	NFI
S	416ac	52ft/ac	120-250 yr	2 cr	NFI
R-S	971ac	45ft/ac	120-250 yr	2 cr	NFI

Figure E-16 Alternative F habitat patch value

Where NFI = no fire impacts, PFI = partial fire impacts.
Data for I/J, O/P, and R/S are for combined habitat patches.

The total amount of interior habitat available within the project area for Alternative F is 5,666 acres. Sixteen habitat patches remain viable under this alternative.

Given that the majority of stands with predicted mortality classes in Layer 1 of G, 0, 1, or 2 generally retained some portion of their secondary canopy, classes of 3 or 4 generally lost all of their secondary canopy and classes 5 to 9 were reduced to open timber stands, the following assumptions were made in predicting Interior Habitat Indices:

All stands exceeding 50 years of age and with PM class of G in Layer 1 were considered for Interior Habitat Index analysis, and were assumed to have retained Layers 2 and 3, if they originally had such layers.

All stands exceeding 50 years of age and with PM class of 0, 1, or 2 in Layer 1 were considered for Interior Habitat Index analysis, and were assumed to have retained at least a portion of Layer 2, but not Layer 3, if they originally had such layers.

All stands exceeding 50 years of age and with PM class of 3 or 4 in Layer 1 were considered marginally acceptable for Interior Habitat Index analysis, and were assumed to have lost Layers 2 and 3, if they originally had such layers.

All stands less than 50 years of age, or exceeding 50 years of age, but with PM class of 5 to 9 in Layer 1 were considered to be unacceptable for Interior Habitat Index analysis.

Interior Habitat Indices were determined for each habitat block by combining values for attributes of different stands occurring within the same habitat block.

The relative values of each of the habitat blocks considered for Interior Habitat Index analysis under Alternative F are shown in Figure E-17.

ID#	SIZE(ac)	ACRE	E/A	AGE	CANOPY	LWD	IHI	ALLOCATION
A	204	0.10	0.31	0.70	0.92	0.50	0.40	-0-
B	230	0.10	0.50	0.70	1.00	0.50	0.45	BEMA,SOHA
C	395	0.13	0.44	0.72	0.64	0.56	0.43	PWHA, SOHA
D	369	0.18	0.63	0.71	0.54	0.60	0.45	PWHA, SOHA
E	497	0.18	0.63	0.78	0.53	0.58	0.49	SOHA
F	177	0.05	0.25	0.68	0.60	0.51	0.30	-0-
H	191	0.05	0.18	0.74	0.62	0.54	0.29	-0-
I	192	0.05	0.25	0.68	0.37	0.51	0.28	-0-
J	549	0.22	0.44	0.48	0.53	0.55	0.42	MHA
I/J	741	0.30	0.44	0.62	0.49	0.54	0.46	-0-
K	181	0.05	0.10	0.55	0.47	0.59	0.24	-0-
L	171	0.05	0.10	0.73	0.34	0.58	0.27	-0-
M	246	0.10	0.31	0.50	0.63	0.50	0.34	MHA
N	844	0.34	0.75	0.56	0.67	0.50	0.54	-0-
O	274	0.10	0.37	0.77	0.82	0.64	0.43	MHA
P	210	0.10	0.10	0.71	0.88	0.65	0.33	MHA
O/P	484	0.18	0.37	0.77	0.85	0.64	0.49	-0-
R	514	0.22	0.63	0.61	0.60	0.53	0.49	-0-
S	416	0.18	0.56	0.65	0.60	0.49	0.45	-0-
R/S	971	0.38	0.63	0.64	0.60	0.51	0.54	-0-

Figure E-17 Alternative F IHI values

An overall index value for habitat quality under this alternative is 0.41. This figure represents the relative quality of the 5,660 acres of interior habitat remaining under this alternative.

TABLE F-1
DOLLAR BENEFITS AND COSTS BY ALTERNATIVE 1/
Years 1989 and 1990

UNDISCOUNTED REVENUES AND COSTS IN YEARS 1989-1990
(millions of dollars)

Resource/Activity	Funds Source	A	B	C	D	F	E
Volume Logged (MMBF)		201.34	164.52	146.88	141.41	101.89	0.00
Timber (Pond) Value		72.72	59.42	53.05	51.47	37.03	0.00
Logging Costs		19.80	16.69	15.02	16.38	10.20	0.00
GROSS FS REVENUES	STUMP	52.93	42.73	38.03	35.09	26.83	0.00
FS Costs		4.05	3.91	3.91	3.00	3.26	-0.70
....Sales prep/Administration	APP	0.03	0.02	0.02	0.02	0.01	0.00
....Regeneration	KV	2.00	1.84	1.80	1.47	1.46	-0.70
....Fuels treatment	BD	0.80	0.79	0.71	0.72	0.55	0.00
....Road construction	RPC	1.22	0.97	0.88	0.31	0.57	0.00
....Mitigation/Monitoring	KV	0.00	0.29	0.50	0.48	0.67	0.00
NET SALES REVENUES		48.83	38.82	34.12	32.09	23.57	-0.70
Mitigation; Monitoring; Rehabilitation	KV	0.00	0.56	0.61	0.60	0.61	0.01
NET FS REVENUES		48.88	38.26	33.51	31.49	22.96	-0.71

AVERAGE TIMBER REVENUES AND COSTS ($/MBF)

Resource/Activity	A	B	C	D	F	E
Timber (Pond) Value	361	361	361	364	363	0
Logging Costs	98	101	102	116	100	0
GROSS FS REVENUES	263	260	259	248	263	0
FS Costs	20	24	27	21	32	n/a
NET SALES REVENUES	243	236	232	227	231	0
Mitigation; Monitoring; Rehabilitation	0	3	4	4	6	n/a
NET FS REVENUES	243	233	228	223	225	n/a

1/ Eighty-five percent of gross volumes are used in calculating all values in this table because logging costs are applied to 85 percent of gross volumes, allowing for 15 percent breakage which will be left on the ground. Timber (pond) values for gross merchantable volumes (i.e. 80 percent of gross volume) presented in Chapter IV are adjusted to reflect this 5 percent difference. The adjusted pond values for this table are $377 (future green sales), $364 (1989 salvage sales), and $353 (1990 salvage sales).

TABLE F-2
PRESENT NET VALUES, COUNTY PAYMENTS, AND MAJOR OUTPUTS BY ALTERNATIVE
(millions of dollars)

PRESENT NET VALUES FOR YEARS 1989-2039
(4 1/8 percent discount rate)

Year	A	B	C	D	F	E
Project (1989-1990)	46.3	36.5	32.0	30.4	22.1	-0.7
Furture Timber Mgmt. (1993-2039)	71.2	67.3	66.0	67.8	66.5	77.7
TOTAL PRESENT NET VALUE	117.5	103.8	98.0	98.2	88.6	77.0

REVENUE SHARING PAYMENTS TO COUNTIES

Year	A	B	C	D	F	E
Project (1989-1990)						
(Undiscounted)						
....Total Revenues (mm$)	13.0	10.5	9.4	8.6	6.6	0.0
....Average Payment $/MBF	69.0	68.0	68.0	65.0	69.0	0.0
Salvage and Future Sales						
(1989-2030 discounted)						
....Total Revenues (mm$)	31.3	27.8	26.3	25.3	24.0	20.8
....Average Payment $/MBF	38.0	38.0	37.0	35.0	36.0	31.0

MAJOR OUTPUTS

Time period/Output	A	B	C	D	F	E
1989-1990						
....Gross Merchantable Volume 1/ (MMBF)	189.6	155.2	138.2	133.1	95.9	0.0
....Harvest Acres	5395.0	4705.0	4623.0	4702.0	2566.0	0.0
....Average Yield (MBF/Acre)	35.0	33.0	30.0	28.0	37.0	0.0
....Planting Acres	3631.0	3011.0	2560.0	1989.0	1987.0	1700.0
1989-2039						
....Gross Merchantable Volume 1/	823.0	731.0	706.0	717.0	668.0	667.0
....Volume Remaining (MMBF)	0.0	68.0	85.0	83.0	90.0	0.0

1/ Gross Merchantable volume is 80 percent of gross volume

TABLE F-3
JOBS AND WAGE INCOME BY ALTERNATIVE
(millions of dollars)

FULL-TIME JOBS
(direct industry jobs)

Industry/Time Period	A	B	C	D	F	E
Sawmill/Veneer Plant						
....1989-1990	885	724	659	622	449	0
....1993-2039	2970	2695	2590	2730	2670	3120
Tree Planting						
....1989-2039	24	19	15	13	13	6
....1993-2039	43	40	35	40	40	45
Road Reconstruction and Maintenance						
....1989-1990	22	12	11	1	7	0
....1993-2039	53	62	63	71	65	76
Forest Service						
....1989-1990	181	148	135	127	91	0
....1993-2039	609	550	530	560	545	640
Subtotal, 1989-1990	1112	903	820	763	560	6
Subtotal, 1993-2039	3567	3347	3218	3401	3320	3881
TOTAL DIRECT JOBS	4679	4250	4038	4164	3880	3887

WAGE INCOME FOR DIRECT JOBS
(millions of dollars)

Industry/Time Period	A	B	C	D	F	E
Sawmill/Veneer Plant						
....1989-1990	18.4	15.1	13.7	12.9	9.4	0
....1993-2039	61.8	56.1	53.8	56.8	55.6	64.9
Tree Planting						
....1989-1990	0.5	0.4	0.3	0.3	0.3	0.1
....1993-2039	1.9	0.8	0.7	0.8	0.8	0.9
Road Reconstruction and Maintenance						
....1989-1990	0.5	0.3	0.3	0.2	0.02	0
....1993-2039	1.2	1.4	1.4	1.6	1.5	1.7
Forest Service						
....1989-1990	3.4	2.8	2.5	2.4	1.7	0
....1993-2039	11.4	10.3	9.9	10.5	10.2	12.0
Subtotal, 1989-1990	22.8	18.5	16.8	15.6	11.5	0.1
Subtotal, 1993-2039	76.3	68.6	66.0	69.7	68.1	79.6
TOTAL WAGE INCOME	99.1	87.1	82.8	85.3	79.6	79.7

HARVEST AREA DETAILED INFORMATION
Derived from
GEOGRAPHIC INFORMATION SYSTEM DATABASE (GIS)

ALTERNATIVE B

DEFINITIONS OF ABBREVIATIONS

AREA Harvest Area number (relates to a specific map location)

PRESC Silvicultural Prescription
- **CC** Clear Cut
- **SH** Shelterwood
- **PC** Partial Cut

AC Area Acres

HMETH Harvest Method
- **CG** Cable Ground Lead
- **HF** Helicopter Full Supension
- **SP** Skyline Partial Suspension
- **SF** Skyline Full Suspension

GGREEN Gross Green volume

GDEAD Gross Dead volume

GIS DATA BASE INFORMATION - ALTERNATIVE B

AREA	PRESC	AC	HMETH	GGREEN	GDEAD
2020	CC	6	HF	0	213
2024	PC	15	SP	0	227
2036	CC	18	SP	819	97
2037 2037	CC PC	13 7	SP SP	0 0	692 43
2038	CC	16	SP	0	962
2041	CC	17	SP	145	543
2051	CC	12	SP	302	390
2055	CC	14	SP	222	435
2056	CC	20	SP	406	706
2057	CC	21	SP	0	1147
2058	CC	11	SP	0	632
2059	CC	18	SP	0	602
2060	CC	10	SP	12	530
2067 2067	CC PC	1 7	SP SP	0 0	42 41
2073	CC	19	SP	0	896
2077 2077	CC PC	16 22	SP SP	0 0	747 228
2078	CC	24	SP	293	1664
2086	PC	14	SP	0	45
2087 2087	CC PC	14 18	SP HF	136 0	577 114
2090	CC	18	SP	0	993
2091	CC	20	SP	30	873
2096 2096	CC PC	13 13	SP SP	0 0	558 140
2097	CC	17	SP	102	511
2098	PC	34	SP	0	363
2100	CC	20	SP	0	708
2154	CC	8	CG	191	350

GIS DATA BASE INFORMATION - ALTERNATIVE B

AREA	PRESC	AC	HMETH	GGREEN	GDEAD
2206	CC	16	SP	553	450
2208	SH	15	SP	116	581
2210	CC	22	SP	756	536
2240 2240	CC PC	9 34	SP SP	0 0	275 213
2248	CC	2	SP	0	86
2258	CC	2	SP	0	96
2260	CC	8	SP	0	396
2270	CC	15	SP	201	399
2272	CC	17	SP	97	388
2274	CC	19	SP	328	699
2276	CC	8	CG	86	435
2278 2278	CC PC	7 12	SP SP	98 0	225 163
2280 2280	CC SH	26 12	SP SP	218 0	239 18
2286	PC	36	SP	0	593
2288 2288	CC PC	12 22	SP SP	0 0	694 483
2290	PC	5	SP	0	38
2292	CC	24	SF	836	774
2296	CC	17	HF	804	526
2298	CC	26	HF	761	829
2460	CC	10	SP	108	354
2474	PC	7	SP	0	162
2476	PC	19	SP	0	146
2478	PC	29	SP	0	245
2500 2500	CC PC	19 24	SP SP	0 0	984 430
2502	SH	20	SP	0	794
2504	CC	5	SP	0	262
2506	CC	4	HF	0	185

GIS DATA BASE INFORMATION - ALTERNATIVE B

AREA	PRESC	AC	HMETH	GGREEN	GDEAD
2508	PC	37	SP	0	987
2510	CC	18	HF	382	402
2512	PC	26	SP	0	23
2513 2513	CC PC	22 8	SP SP	578 0	525 93
2514	CC	6	SP	126	142
2516	CC	7	CG	123	106
2518	CC	6	SP	0	254
2520	CC	12	SP	90	502
2522	CC	37	SP	590	1127
2524 2524	CC PC	10 4	SP SP	0 0	417 23
2526	CC	10	SP	236	312
2528 2528	CC SH	14 14	SP SP	90 0	420 46
2530 2530	CC PC	4 6	SP SP	0 0	158 46
2532 2532	CC SH	20 22	SP SP	130 0	646 236
2534 2534	CC PC	6 10	SP SP	0 0	254 100
2536 2536	CC PC	18 6	SP SP	462 0	498 46
2538	CC	8	SP	142	186
2540 2540	CC PC	3 23	SP SP	0 0	162 150
2542 2542	CC PC	12 12	SP SP	0 0	636 35
2544	CC	14	SP	0	739
2546	CC	25	SP	0	1317
2548	CC	6	SP	0	286
2550	PC	27	SP	0	337
2552	PC	28	SP	0	446

GIS DATA BASE INFORMATION - ALTERNATIVE B

AREA	PRESC	AC	HMETH	GGREEN	GDEAD
2554	CC	9	SP	46	399
2554	PC	21	SP	0	190
2556	CC	12	SP	58	498
2558	CC	12	SP	181	417
2560	SH	32	HF	396	1144
2562	CC	10	SP	25	374
2562	PC	4	SP	0	22
2564	CC	10	HF	0	494
2564	SH	6	SP	0	46
2566	PC	18	SP	0	174
2568	CC	3	SP	0	150
2568	PC	13	SP	0	100
2570	SH	2	HF	0	94
2572	CC	5	SP	5	214
2574	CC	6	SP	14	267
2574	PC	11	SP	0	40
2576	CC	13	HF	0	373
2576	PC	19	HF	0	77
2578	CC	8	SP	0	306
2580	CC	42	SP	0	1624
2580	PC	20	SP	0	189
2582	SH	35	SP	115	1298
2584	CC	8	SP	0	362
2584	PC	10	SP	0	210
2586	CC	2	SP	0	96
2586	PC	8	SP	0	26
2588	CC	12	SP	37	610
2590	SH	6	HF	0	188
2590	PC	18	HF	0	144
2594	PC	11	SP	0	118
2598	CC	6	SP	28	304
2600	CC	8	HF	0	308
2604	SH	65	SP	282	2090
2606	SH	8	HF	50	274
2608	CC	4	SP	36	135

GIS DATA BASE INFORMATION - ALTERNATIVE B

AREA	PRESC	AC	HMETH	GGREEN	GDEAD
2610	CC	6	SP	0	331
2612	CC	41	SP	0	1928
2616 2616	CC PC	48 24	SP SP	0 0	2285 218
2618	PC	8	SP	0	81
2619	CC	18	SP	108	9
2620	PC	8	SP	0	65
2624	PC	20	SP	0	194
2626	CC	24	SP	0	1270
2628	CC	10	SP	0	527
2630	CC	20	SP	0	1002
2634	CC	24	HF	0	1228
2636	CC	66	SP	0	3159
2638	CC	5	SP	0	77
2640 2640	CC PC	2 36	SP SP	42 0	48 389
2642	PC	16	HF	0	178
2644	PC	42	SP	0	466
2646 2646	CC PC	15 35	SP SP	20 0	606 253
2648	CC	12	SP	0	450
2650 2650	CC PC	11 12	SP SP	277 0	234 174
2652	CC	46	SP	1314	911
2656 2656	CC PC	5 13	HF HF	0 0	263 221
2658	CC	19	SP	182	736
2660	CC	9	HF	28	402
2662 2662	CC PC	7 40	HF HF	0 0	334 792
2664 2664	CC PC	4 36	SP SP	0 0	191 722
2666	CC	10	SP	362	94

GIS DATA BASE INFORMATION - ALTERNATIVE B

AREA	PRESC	AC	HMETH	GGREEN	GDEAD
2668 2668	CC PC	24 38	SP HF	583 0	478 389
2670 2670	CC PC	10 8	SP SP	0 0	478 106
2672	PC	16	HF	0	310
2674	PC	34	SP	0	377
2676	PC	30	SP	0	258
2678	PC	9	SP	0	76
2680	PC	9	SP	0	70
2682 2682	CC PC	10 11	SP SP	0 0	510 133
2684	SH	19	SP	0	395
2686	SH	20	SP	40	414
2688	PC	7	SP	0	75
2690 2690	CC SH	8 6	HF HF	0 0	324 35
2692	PC	5	HF	0	54
2808	CC	3	SP	48	97
2809	CC	5	SP	97	112
2810	CC	1	SP	10	10
2811	CC	4	SP	77	90
2812	CC	9	SP	183	213
2813	CC	9	SP	30	346
2814	CC	10	SP	0	375
2815	CC	35	HF	0	1346
2816	PC	42	SP	0	1036
2817	CC	9	SP	0	243
2818	CC	14	SP	0	583
2819	CC	10	SP	0	438
2820	CC	26	SP	135	927
2822	CC	2	SP	30	75

GIS DATA BASE INFORMATION - ALTERNATIVE B

AREA	PRESC	AC	HMETH	GGREEN	GDEAD
2823	CC	22	SP	0	617
2824	CC	10	SP	0	389
2824	PC	10	SP	0	66
2826	CC	6	SP	0	287
2826	PC	2	SP	0	10
2827	CC	1	SP	0	60
2827	PC	4	SP	0	31
2828	PC	8	SP	0	25
2837	PC	2	SP	0	10
2838	PC	1	SP	0	6
2840	PC	10	SP	0	62
2841	CC	10	SP	0	472
2841	PC	15	SP	0	93
2842	PC	13	SP	0	80
2851	CC	5	SP	0	278
2851	PC	9	SP	0	58
2852	CC	9	SP	0	389
2852	PC	2	SP	0	25
2853	CC	6	CG	27	253
2854	CC	1	SP	0	52
2855	PC	14	SP	0	154
2856	CC	3	SP	0	150
5004	CC	3	SP	0	181
5008	CC	3	SP	0	181
5010	CC	8	SP	0	302
5012	PC	6	CG	0	28
5014	PC	8	SP	0	59
5016	CC	10	SP	0	417
5016	PC	6	SP	0	59
5018	CC	23	SP	46	1182
5020	CC	8	SP	0	353
5020	PC	5	SP	0	54
5022	CC	16	SP	0	812

GIS DATA BASE INFORMATION - ALTERNATIVE B

AREA	PRESC	AC	HMETH	GGREEN	GDEAD
5024	CC	20	SP	0	932
5026	CC	6	CG	0	287
5028	CC	9	SP	0	229
5030	CC	3	SP	19	106
5044	CC	8	SP	176	185
5048 5048	CC PC	22 12	SP SP	0 0	1730 97
5056	CC	6	SP	145	236
5058	CC	9	SP	179	271
5062	CC	6	SF	0	275
5068	CC	1	SP	0	38
5070 5070	CC PC	4 6	SP SP	116 0	58 207
5072	CC	2	SP	0	102
5074	CC	3	CG	0	127
5078	CC	16	SP	0	477
5080	CC	7	SP	0	352
5082	CC	24	SP	74	1054
5084	CC	30	SP	416	505
5086	CC	23	SP	0	1103
5088	CC	5	SP	0	139
5090	CC	7	SP	0	226
5092	CC	12	SP	0	230
5094 5094	CC PC	3 6	SP SP	0 0	87 16
5096	CC	20	SP	414	281
5098	PC	12	SF	0	8
5100	CC	1	SF	10	31
5116	CC	8	SP	0	625
5118	CC	4	SP	0	208
5120	CC	8	SP	0	604

GIS DATA BASE INFORMATION - ALTERNATIVE B

AREA	PRESC	AC	HMETH	GGREEN	GDEAD
5122	CC	8	SP	0	625
5124	CC	30	SP	0	1768
5126	CC	14	SP	0	630
5128	CC	15	SP	0	1229
5130	CC	1	SP	38	45
5132	CC	8	SP	0	424
5134	CC	7	SP	0	391
5136	CC	9	SP	0	468
5138	CC	13	SP	0	782
5140	CC	8	SP	0	45
5142	CC	19	SP	0	993
5144	CC	25	SP	0	1474
5146	CC	10	SP	0	222
5148	CC	44	SP	764	1444
5150	CC	16	SP	97	766
5152	CC	8	SP	0	340
5156	CC	12	SP	14	604
5238	CC	6	SP	135	189
5240 5240	CC PC	6 26	SP SP	0 0	254 244
5242 5242	CC PC	1 7	SP SP	7 0	28 70
5244 5244	CC PC	1 7	SP SP	14 0	54 70
5246	PC	11	SP	0	108
5248	CC	6	CG	55	219
5250 5250	CC PC	3 4	CG SP	28 0	110 43
5252	CC	6	CG	62	246
5254 5254	CC PC	3 8	SP SP	15 0	179 81
5256	PC	20	SP	0	138

GIS DATA BASE INFORMATION - ALTERNATIVE B

AREA	PRESC	AC	HMETH	GGREEN	GDEAD
5264 5264	CC PC	5 12	SP SP	0 0	324 108
5266 5266	CC PC	1 11	SP SP	0 0	32 178
5268 5268	CC PC	2 3	SP SP	0 0	97 46
5270	CC	4	SP	0	259
5272 5272	CC PC	1 9	SP SP	0 0	32 46
5274 5274	CC PC	6 11	SP SP	0 0	474 45
5276	CC	8	SP	410	199
5280	PC	2	CG	0	15
5300	PC	8	SP	0	23
5396	CC	8	SP	0	438
5402 5402	CC PC	5 1	SP HF	230 0	131 5
5404	PC	6	SP	0	49
5406	PC	6	SP	0	42
5420	CC	8	SP	309	210
5422 5422	CC PC	20 11	SP SP	235 0	1092 126
5432	CC	14	SP	459	439
5434	CC	20	SP	558	614
5436	CC	16	HF	355	415
5438	CC	14	SP	490	340
5440	PC	8	SP	0	128
5442	CC	14	SP	618	354
5444	CC	9	SP	347	236
5446	CC	12	SP	386	262
5448	CC	15	SP	0	666
5450	CC	10	SP	0	583
5452	CC	6	CG	86	270

GIS DATA BASE INFORMATION - ALTERNATIVE B

AREA	PRESC	AC	HMETH	GGREEN	GDEAD
5454	PC	6	SP	0	38
5456	PC	6	SP	0	25
5458	CC	6	CG	0	340
5460	CC	6	CG	58	99
5462	CC	5	CG	0	146
5464	CC	9	SP	42	194
5466	CC	12	SP	0	467
5468	CC	12	SP	0	438
5470 5470	CC PC	15 4	SP SP	0 0	417 21
5472 5472	CC PC	2 6	SP SP	0 0	55 37
5474 5474	CC PC	8 12	SP SP	0 0	222 59
5476	CC	11	SP	0	291
5478	CC	8	SP	60	210
5480 5480	CC PC	6 12	SP SP	97 0	65 78
5482	CC	10	SP	54	321
5484	CC	2	SP	17	43
5486	SH	6	SP	57	138
5488	PC	12	SP	0	170
5490	PC	6	SP	0	112
5492	PC	8	SP	0	98
5494	CC	11	SP	17	281
5496	CC	12	SP	30	245
5500	CC	16	SP	89	655
5506	CC	2	SP	0	93
5512	CC	8	CG	96	162
5514	PC	36	SF	0	293
5516	CC	11	SP	0	275
5518	CC	28	SP	105	794

GIS DATA BASE INFORMATION - ALTERNATIVE B

AREA	PRESC	AC	HMETH	GGREEN	GDEAD
5520 5520	CC PC	2 22	HF HF	0 0	104 70
5532	CC	2	HF	0	174
5568	CC	1	SP	0	32
5572 5572	CC PC	11 25	SP HF	0 0	846 386
5636	CC	9	SP	110	166
5638	CC	8	SP	60	199
5640	CC	4	CG	0	210
9999	CC	15	SP	0	881
TOTALS:		4,695		23,633	135,141

HARVEST AREA DETAILED INFORMATION
Derived from
GEOGRAPHIC INFORMATION SYSTEM DATABASE (GIS)

ALTERNATIVE C

DEFINITIONS OF ABBREVIATIONS

AREA Harvest Area number (relates to a specific map location)

PRESC Silvicultural Prescription
- **CC** Clear Cut
- **SH** Shelterwood
- **PC** Partial Cut

AC Area Acres

HMETH Harvest Method
- **CG** Cable Ground Lead
- **HF** Helicopter Full Supension
- **SP** Skyline Partial Suspension
- **SF** Skyline Full Suspension

GGREEN Gross Green volume

GDEAD Gross Dead volume

GIS DATA BASE INFORMATION - ALTERNATIVE C

AREA	PRESC	AC	HMETH	GGREEN	GDEAD
2020	CC	6	SP	0	206
2024	PC	15	SP	0	215
2036	CC	18	SP	810	96
2037	CC	13	SP	0	686
2037	PC	7	SP	0	35
2038	CC	16	SP	0	960
2041	CC	17	SP	142	530
2051	CC	4	SP	0	178
2055	CC	14	SP	134	426
2056	CC	20	SP	349	701
2057	CC	21	SP	0	873
2058	CC	11	SP	0	629
2059	CC	18	SP	0	581
2060	CC	10	SP	12	395
2067	CC	1	SP	0	41
2067	PC	7	SP	0	33
2073	CC	19	SP	0	862
2077	CC	16	SP	0	737
2077	PC	22	SP	0	206
2078	CC	19	SP	0	1380
2078	PC	5	SP	0	121
2086	PC	14	SP	0	27
2087	CC	14	SP	134	571
2087	PC	18	HF	0	93
2090	CC	18	SP	0	986
2091	CC	20	SP	29	859
2096	CC	13	SP	0	547
2096	PC	13	SP	0	127
2097	CC	17	SP	98	496
2098	PC	34	SP	0	330
2100	CC	20	SP	0	686

GIS DATA BASE INFORMATION - ALTERNATIVE C

AREA	PRESC	AC	HMETH	GGREEN	GDEAD
2154	CC	8	CG	191	350
2206	PC	16	SP	0	445
2208	SH	15	SP	114	572
2210	PC	22	SP	0	526
2240 2240	CC PC	8 20	SP SP	0 0	266 193
2248	CC	2	SP	0	0
2258	CC	2	SP	0	94
2260	CC	8	SP	0	391
2270	CC	15	SP	196	390
2272	CC	14	SP	19	362
2274	CC	19	SP	302	694
2276	CC	8	CG	18	433
2278 2278	CC PC	7 12	SP SP	34 0	218 153
2280 2280	CC SH	15 23	SP SP	218 0	845 170
2286	PC	18	SP	0	562
2288 2288	CC PC	12 22	SP SP	0 0	691 471
2290	PC	5	SP	0	33
2292	PC	24	SF	0	769
2296	PC	17	HF	0	522
2298	CC	26	SP	457	820
2460	CC	10	SP	106	350
2474	PC	7	SP	0	158
2476	PC	19	SP	0	126
2478	PC	29	SP	0	213
2500 2500	CC PC	19 24	SP SP	0 0	975 412
2502 2502	CC SH	14 6	SP SP	0 0	714 69

GIS DATA BASE INFORMATION - ALTERNATIVE C

AREA	PRESC	AC	HMETH	GGREEN	GDEAD
2510	PC	18	HF	0	393
2512	PC	26	SP	0	204
2513 2513	CC PC	22 8	SP SP	572 0	519 85
2514	PC	6	SP	0	140
2516	PC	7	CG	0	102
2518	CC	6	SP	0	250
2520	CC	12	SP	89	496
2522 2522	CC PC	16 21	HF HF	584 0	727 414
2524 2524	CC PC	10 4	SP SP	0 0	408 18
2526 2526	CC PC	6 4	SP SP	238 0	302 9
2528 2528	CC SH	7 21	SP SP	0 0	269 169
2530 2530	CC PC	4 6	SP SP	0 0	154 40
2532 2532	CC SH	11 31	SP SP	129 0	475 375
2534 2534	CC PC	6 10	HF HF	0 0	250 90
2536 2536	CC PC	2 22	HF HF	476 0	94 440
2538	CC	3	SP	144	164
2540 2540	CC PC	3 23	SP SP	0 0	161 124
2542 2542	CC PC	12 12	SP SP	0 0	631 20
2544	CC	14	SP	0	733
2546	CC	25	SP	0	1306
2548	CC	6	SP	0	282
2550	PC	27	SP	0	312
2552	PC	28	SP	0	424
2554 2554	CC PC	9 21	SP SP	46 0	376 168

GIS DATA BASE INFORMATION - ALTERNATIVE C

AREA	PRESC	AC	HMETH	GGREEN	GDEAD
2556	CC	12	SP	58	490
2558 2558	CC PC	9 3	SP SP	46 0	396 13
2560 2560	CC SH	24 8	SP HF	107 0	1086 37
2562 2562	CC PC	10 4	SP SP	24 0	365 17
2564	SH	10	HF	0	489
2566 2566	CC PC	1 17	SP SP	6 0	46 108
2568 2568	CC PC	3 13	SP SP	0 0	149 86
2570 2570	CC SH	2 19	HF HF	0 0	93 87
2572	CC	5	SP	5	210
2574 2574	CC PC	6 11	SP SP	14 0	263 26
2576 2576	CC PC	13 19	HF HF	0 0	355 54
2578	CC	8	SP	0	298
2580 2580	CC PC	42 20	SP SP	0 0	1552 168
2582	SH	35	SP	48	1294
2584 2584	CC PC	8 10	SP SP	0 0	356 204
2586 2586	CC PC	2 8	SP SP	0 0	94 16
2588	CC	12	SP	0	606
2590 2590	CC SH	2 22	HF HF	0 0	94 214
2594	PC	11	SP	0	108
2598	CC	6	SP	27	302
2600 2600	CC PC	8 30	HF HF	0 0	300 120
2604 2604	CC SH	47 18	SP SP	278 0	1948 96

GIS DATA BASE INFORMATION - ALTERNATIVE C

AREA	PRESC	AC	HMETH	GGREEN	GDEAD
2606	CC	8	SP	48	269
2608	CC	4	SP	35	132
2610	CC	6	SP	0	329
2612	CC	41	SP	0	1901
2616 2616	CC PC	48 24	SP SP	0 0	2254 193
2618	PC	8	SP	0	73
2619	CC	18	SP	37	4
2620	PC	8	SP	0	56
2624	PC	20	SP	0	174
2626	CC	24	SP	0	1259
2628	CC	10	SP	0	523
2630	CC	20	SP	0	992
2632	CC	10	SP	0	472
2634	CC	24	HP	0	1216
2636	CC	66	SP	0	2964
2638	CC	5	SP	0	68
2640 2640	CC PC	2 36	SP SP	41 0	47 353
2642	PC	16	HF	0	162
2644 2644	CC PC	2 40	SP SP	0 0	94 341
2646	PC	50	SP	0	193
2648	CC	12	SP	0	330
2650 2650	CC PC	2 21	SP SP	283 0	74 318
2652 2652	CC PC	22 24	HF HF	450 0	493 391
2656 2656	CC PC	5 13	HF HF	0 0	261 210
2658 2658	CC PC	13 6	HF HF	182 0	621 110
2660	CC	9	HF	27	398

GIS DATA BASE INFORMATION - ALTERNATIVE C

AREA	PRESC	AC	HMETH	GGREEN	GDEAD
2662	CC	7	HF	0	330
2662	PC	40	SP	0	766
2664	CC	4	SP	0	189
2664	PC	36	SP	0	698
2666	CC	10	SP	357	92
2668	CC	24	SP	573	470
2668	PC	36	SP	0	353
2670	CC	10	SP	0	472
2670	PC	8	SP	0	99
2672	PC	16	HF	0	298
2674	PC	34	SP	0	344
2676	PC	30	SP	0	226
2678	PC	9	SP	0	66
2680	PC	9	SP	0	59
2682	CC	10	SP	0	505
2682	PC	11	SP	0	122
2684	CC	8	SP	0	107
2684	SH	11	SP	0	268
2686	CC	20	SP	38	385
2688	PC	7	SP	0	69
2690	CC	4	HF	0	242
2690	SH	10	HF	0	107
2808	CC	3	SP	47	96
2809	CC	5	SP	94	110
2810	CC	1	SP	9	10
2811	CC	4	SP	75	88
2812	CC	9	SP	180	209
2813	CC	9	SP	29	338
2814	CC	10	SP	0	365
2815	CC	35	HF	0	1312
2816	PC	42	SP	0	1016
2817	CC	9	SP	0	230
2818	CC	14	SP	0	571
2819	CC	10	SP	0	430

GIS DATA BASE INFORMATION - ALTERNATIVE C

AREA	PRESC	AC	HMETH	GGREEN	GDEAD
2820	CC	26	SP	132	906
2822	CC	2	SP	29	75
2823	CC	22	SP	0	573
2824 2824	CC PC	10 10	SP SP	0 0	379 54
2826 2826	CC PC	6 2	SP SP	0 0	283 9
2827 2827	CC PC	1 4	SP SP	0 0	60 26
2828	PC	8	CG	0	14
2837	PC	2	SP	0	7
2838	PC	1	SP	0	5
2840	PC	10	SP	0	50
2841 2841	CC PC	10 15	SP SP	0 0	466 75
2842	PC	13	SP	0	65
2851 2851	CC PC	5 9	SP SP	0 0	276 48
2852 2852	CC PC	9 2	SP SP	0 0	382 23
2853	CC	6	CG	26	192
2854	CC	1	SP	0	12
2855	PC	14	SP	0	141
2856	CC	3	SP	0	149
5004	CC	3	SP	0	180
5008	CC	3	SP	0	180
5010	CC	8	SP	0	294
5012	PC	6	CG	0	21
5014	PC	8	SP	0	50
5016 5016	CC PC	10 6	SP SP	0 0	408 54
5018 5018	CC PC	21 2	SP SP	0 0	1159 14
5020 5020	CC PC	8 5	SP SP	0 0	1260 49

GIS DATA BASE INFORMATION - ALTERNATIVE C

AREA	PRESC	AC	HMETH	GGREEN	GDEAD
5022	CC	16	SP	0	804
5024	CC	20	SP	90	934
5026	CC	6	CG	0	283
5028	CC	9	SP	0	216
5030	CC	3	SP	19	103
5044	CC	8	SP	173	182
5046 5046	CC PC	1 5	SP SP	0 0	87 170
5048 5048	CC PC	22 12	SP SP	0 0	1742 83
5052 5052	CC PC	5 2	SP SP	0 0	378 48
5056	CC	6	SP	145	236
5058	CC	9	SP	177	269
5062	CC	6	SP	0	174
5070 5070	CC PC	4 6	SP SP	0 0	131 94
5072	CC	2	SP	0	101
5074	CC	4	CG	46	127
5078	CC	16	SP	0	456
5080	CC	7	SP	0	348
5082	CC	24	SP	72	1038
5084	CC	15	SP	0	451
5086	CC	23	SP	0	1090
5088	CC	5	SP	0	132
5090	CC	7	HF	0	218
5092	PC	16	SP	0	217
5094 5094	CC PC	3 6	HF HF	0 0	83 9
5096	PC	20	SP	0	263
5100	CC	1	SF	9	30
5116	CC	8	SP	0	629
5118	CC	4	SP	0	206

GIS DATA BASE INFORMATION - ALTERNATIVE C

AREA	PRESC	AC	HMETH	GGREEN	GDEAD
5120	CC	8	SP	0	478
5122	CC	8	SP	0	607
5124	CC	30	SP	0	1697
5126	CC	14	SP	0	591
5128	CC	15	SP	0	1238
5130	CC	1	SP	39	45
5132	CC	8	SP	0	341
5134	CC	7	CG	0	339
5136	CC	9	SP	0	406
5138	CC	13	SP	0	780
5140	CC	8	SP	0	449
5142	CC	19	SP	0	984
5144	CC	25	SP	0	1469
5146	CC	10	SP	0	206
5148	PC	44	SP	0	1436
5150	CC	16	SP	97	760
5152	CC	8	SP	0	334
5156	CC	12	SP	14	598
5238	CC	6	SP	134	187
5240 5240	CC PC	6 26	SP SP	0 0	250 217
5242 5242	CC PC	1 7	SP SP	6 0	27 63
5244 5244	CC PC	1 7	SP SP	14 0	55 63
5246	PC	11	SP	0	97
5248	CC	6	CG	54	216
5250 5250	CC PC	3 4	CG SP	27 0	108 39
5252	CC	6	CG	62	244
5254 5254	CC PC	3 8	CG SP	15 0	179 73
5256	PC	20	SP	0	114

GIS DATA BASE INFORMATION - ALTERNATIVE C

AREA	PRESC	AC	HMETH	GGREEN	GDEAD
5264	CC	5	HF	0	324
5264	PC	12	HF	0	95
5266	PC	17	SP	0	200
5268	CC	2	SP	0	94
5268	PC	3	SP	0	44
5270	CC	4	HF	0	259
5272	PC	10	SP	0	68
5274	CC	6	HF	0	465
5274	PC	11	SP	0	31
5276	CC	8	SP	382	200
5280	PC	2	CG	0	14
5300	PC	8	SP	0	13
5396	CC	8	SP	0	434
5402	PC	6	SP	0	153
5404	PC	6	SP	0	42
5406	PC	6	SP	0	36
5420	CC	8	SP	309	210
5422	PC	31	SP	0	1222
5432	CC	14	SP	428	439
5434	CC	20	SP	333	606
5436	CC	16	HF	230	406
5438	CC	14	SP	336	336
5440	PC	8	SP	0	122
5442	CC	14	SP	619	355
5444	CC	9	SP	347	236
5446	CC	12	SP	382	260
5448	CC	15	SP	0	655
5450	CC	10	SP	0	581
5452	CC	6	CG	86	269
5454	PC	6	SP	0	32
5456	PC	6	SP	0	18
5458	CC	6	CG	0	305

GIS DATA BASE INFORMATION - ALTERNATIVE C

AREA	PRESC	AC	HMETH	GGREEN	GDEAD
5460	CC	6	CG	13	90
5462	CC	5	CG	0	106
5464	CC	9	SP	39	184
5466	CC	12	SP	0	456
5468	CC	12	SP	0	425
5470 5470	CC PC	15 4	SP SP	0 0	396 16
5472 5472	CC PC	2 6	SP SP	0 0	53 30
5474	PC	20	SP	0	264
5476	CC	11	SP	0	276
5478	CC	8	SP	58	203
5480	PC	18	SP	0	124
5482	CC	10	SP	53	312
5484	CC	2	SP	16	42
5486	PC	6	SP	0	134
5488	PC	12	SP	0	159
5490	PC	6	SP	0	108
5492	PC	8	SP	0	91
5494	CC	11	SP	16	234
5496	CC	12	SP	3	225
5500	CC	16	SP	87	646
5506	CC	2	SP	0	91
5512	CC	5	CG	0	156
5514	PC	36	SF	0	254
5516	CC	11	SP	0	259
5518	CC	28	SP	86	763
5520 5520	CC PC	2 22	HF HF	0 0	103 42
5532	CC	3	HF	0	173
5568	CC	1	SP	0	31

GIS DATA BASE INFORMATION - ALTERNATIVE C

AREA	PRESC	AC	HMETH	GGREEN	GDEAD
5572 5572	CC PC	11 10	SP HF	0 0	810 386
5636	CC	9	SP	106	159
5638	CC	8	SP	58	191
5640	CC	4	CG	0	209
9999	CC	15	SP	0	880
TOTALS:		4,609		14,123	129,867

HARVEST AREA DETAILED INFORMATION
Derived from
GEOGRAPHIC INFORMATION SYSTEM DATABASE (GIS)

ALTERNATIVE D

DEFINITIONS OF ABBREVIATIONS

AREA Harvest Area number (relates to a specific map location)

PRESC Silvicultural Prescription
- **CC** Clear Cut
- **SH** Shelterwood
- **PC** Partial Cut

AC Area Acres

HMETH Harvest Method
- **CG** Cable Ground Lead
- **HF** Helicopter Full Supension
- **SP** Skyline Partial Suspension
- **SF** Skyline Full Suspension

GGREEN Gross Green volume

GDEAD Gross Dead volume

GIS DATA BASE INFORMATION - ALTERNATIVE D

AREA	PRESC	AC	HMETH	GGREEN	GDEAD
2020	CC	6	HF	0	206
2024	PC	15	SP	0	215
2036	PC	18	SP	0	96
2037 2037	CC PC	13 7	HF HF	0 0	686 35
2038	CC	16	SP	0	960
2041 2041	CC PC	19 8	HF HF	0 0	366 163
2051	CC	4	SP	0	178
2055	PC	12	SP	0	426
2056 2056	CC PC	3 17	HF HF	0 0	88 611
2057	CC	21	HF	0	873
2058	CC	11	HF	0	629
2059	CC	18	HF	0	581
2060 2060	CC PC	9 1	CG CG	0 0	382 13
2067 2067	CC PC	1 7	SP SP	0 0	41 33
2073	CC	19	HF	0	862
2077 2077	CC PC	16 22	HF HF	0 0	737 206
2078 2078	CC PC	19 5	HF HF	0 0	1380 121
2086	PC	14	HF	0	27
2087 2087	CC PC	10 14	SP HF	0 0	405 259
2090	CC	18	SP	0	986
2091 2091	CC PC	18 1	SP SP	0 0	830 30
2096 2096	CC PC	13 13	SP SP	0 0	547 127
2097	CC	15	HF	0	496
2098	PC	34	HF	0	330
2100	CC	20	SP	0	686

GIS DATA BASE INFORMATION - ALTERNATIVE D

AREA	PRESC	AC	HMETH	GGREEN	GDEAD
2154	PC	8	SP	0	350
2206	PC	16	HF	0	445
2208 2208	CC SH	6 9	HF HF	0 0	319 253
2210	PC	22	SP	0	526
2240 2240	CC PC	8 20	HF HF	0 0	266 193
2258	CC	2	HF	0	99
2260	CC	8	SP	0	410
2270 2270	CC PC	5 10	SP SP	0 0	194 196
2272 2272	CC PC	13 1	SP SP	0 0	337 25
2274 2274	CC PC	11 8	SP SP	0 0	476 218
2276 2276	CC PC	6 2	CG CG	0 0	418 14
2278 2278	CC PC	2 17	HF HF	0 0	217 154
2280 2280	CC SH	15 23	SP SP	0 0	845 170
2286	PC	18	SP	0	562
2288 2288	CC PC	12 22	SP SP	0 0	691 471
2290	PC	5	SP	0	33
2292	PC	24	SF	0	769
2296	PC	17	HF	0	522
2298	PC	26	HF	0	820
2458	PC	16	HF	0	48
2460 2460	CC PC	3 7	SP SP	0 0	138 214
2474	PC	7	HF	0	158
2476	PC	19	HF	0	126
2478	PC	29	HF	0	213

GIS DATA BASE INFORMATION - ALTERNATIVE D

AREA	PRESC	AC	HMETH	GGREEN	GDEAD
2500	CC	19	SP	0	975
2500	PC	24	HF	0	412
2502	CC	14	SP	0	714
2502	SH	6	SP	0	69
2504	CC	5	HF	0	256
2504	PC	14	HF	0	193
2506	CC	4	HF	0	181
2506	PC	12	SP	0	108
2508	PC	37	HF	0	1024
2510	PC	18	HF	0	393
2512	PC	26	SP	0	204
2513	CC	4	SP	0	162
2513	PC	26	SP	0	440
2514	PC	6	SP	0	140
2515	PC	1	SP	0	25
2516	PC	7	CG	0	102
2518	CC	6	HF	0	250
2520	CC	11	HF	0	480
2520	PC	1	HF	0	16
2522	CC	16	HF	0	727
2522	PC	21	HF	0	414
2524	CC	10	SP	0	408
2524	PC	4	SP	0	18
2526	CC	6	SP	0	302
2526	PC	4	SP	0	9
2528	CC	7	SP	0	269
2528	SH	21	SP	0	169
2530	CC	4	SP	0	154
2530	PC	6	SP	0	40
2531	CC	11	SP	0	475
2532	PC	31	SP	0	375
2534	CC	6	HF	0	250
2534	PC	10	HF	0	90
2536	CC	2	HF	0	94
2536	PC	22	HF	0	440
2538	CC	3	SP	0	164

GIS DATA BASE INFORMATION - ALTERNATIVE D

AREA	PRESC	AC	HMETH	GGREEN	GDEAD
2540	CC	3	SP	0	161
2540	PC	23	SP	0	124
2542	CC	12	HF	0	631
2542	PC	12	HF	0	20
2544	CC	14	HF	0	733
2548	CC	6	SP	0	282
2550	PC	27	HF	0	312
2552	PC	28	HF	0	424
2554	PC	30	HF	0	613
2556	PC	12	HF	0	516
2558	PC	12	HF	0	432
2560	PC	32	HF	0	1186
2562	PC	14	SP	0	410
2566	PC	18	HF	0	181
2568	CC	3	SP	0	149
2568	PC	13	SP	0	86
2570	PC	21	HF	0	180
2572	CC	5	SP	0	210
2574	CC	4	SP	0	207
2574	PC	13	SP	0	111
2576	CC	13	SP	0	355
2576	PC	19	SP	0	54
2578	CC	8	HF	0	298
2580	CC	42	SP	0	1552
2580	PC	20	SP	0	168
2582	CC	26	HF	0	1191
2582	SH	9	HF	0	97
2584	CC	8	HF	0	213
2584	PC	10	HF	0	169
2586	CC	2	SP	0	94
2586	PC	8	SP	0	16
2588	CC	8	SP	0	448
2588	PC	4	SP	0	186
2590	CC	2	HF	0	94
2590	SH	22	HF	0	214
2592	CC	4	HF	0	202

GIS DATA BASE INFORMATION - ALTERNATIVE D

AREA	PRESC	AC	HMETH	GGREEN	GDEAD
2594	PC	11	HF	0	108
2598	CC	3	HF	0	176
2598	PC	3	HF	0	139
2600	CC	8	HF	0	300
2600	PC	30	HF	0	120
2604	CC	29	HF	0	1396
2604	SH	36	HF	0	650
2606	CC	5	HF	0	248
2606	PC	3	HF	0	19
2608	CC	3	SP	0	122
2608	PC	1	SP	0	10
2610	CC	6	SP	0	329
2612	CC	41	SP	0	1901
2616	CC	48	HF	0	2254
2616	PC	24	HF	0	193
2618	PC	8	HF	0	73
2620	PC	8	HF	0	56
2624	PC	20	SP	0	174
2626	CC	24	SP	0	1259
2628	CC	10	SP	0	523
2630	CC	20	SP	0	992
2632	CC	10	SP	0	472
2634	CC	24	HF	0	1216
2636	CC	66	HF	0	2964
2638	CC	5	HF	0	68
2640	PC	38	SP	0	400
2642	PC	16	HF	0	162
2644	CC	2	SP	0	94
2644	PC	40	SP	0	341
2646	PC	50	SP	0	738
2648	CC	12	HF	0	330
2650	CC	2	HF	0	74
2650	PC	21	HF	0	318
2652	PC	46	HF	0	884

GIS DATA BASE INFORMATION - ALTERNATIVE D

AREA	PRESC	AC	HMETH	GGREEN	GDEAD
2656 2656	CC PC	5 13	HF HF	0 0	261 210
2658 2658	CC PC	13 6	HF HF	0 0	621 110
2660 2660	CC PC	8 1	HF HF	0 0	397 21
2662 2662	CC PC	7 40	HF HF	0 0	330 766
2664 2664	CC PC	4 36	SP SP	0 0	189 698
2666	PC	10	HF	0	92
2668	PC	60	SP	0	822
2670 2670	CC PC	10 8	HF HF	0 0	472 99
2672	PC	16	HF	0	298
2674	PC	34	HF	0	344
2676	PC	30	HF	0	226
2678	PC	9	SP	0	66
2680	PC	9	SP	0	59
2682 2682	CC PC	10 11	SP SP	0 0	505 122
2684 2684	CC SH	8 11	SP SP	0 0	107 268
2686 2686	CC SH	8 12	HF HF	0 0	99 286
2688	PC	7	HF	0	69
2690 2690	CC SH	4 10	HF HF	0 0	242 107
2808 2808	CC PC	1 2	SP SP	0 0	41 55
2809	PC	5	SP	0	110
2810	PC	1	SP	0	10
2811	PC	4	SP	0	88
2812	PC	9	HF	0	209

GIS DATA BASE INFORMATION - ALTERNATIVE D

AREA	PRESC	AC	HMETH	GGREEN	GDEAD
2813	CC	8	SP	0	306
2813	PC	1	SP	0	33
2814	CC	10	SP	0	365
2815	CC	35	HF	0	1312
2816	PC	42	SP	0	1016
2817	CC	9	SP	0	230
2818	CC	14	SP	0	571
2819	CC	10	SP	0	430
2820	CC	19	HF	0	751
2820	PC	7	HF	0	153
2822	PC	2	SP	0	75
2823	CC	22	SP	0	573
2824	CC	10	HF	0	379
2824	PC	10	HF	0	54
2826	CC	6	SP	0	283
2826	PC	2	SP	0	9
2827	CC	1	SP	0	60
2827	PC	4	SP	0	26
2828	PC	4	SP	0	14
2829	PC	10	HF	0	38
2839	PC	5	HF	0	32
2840	PC	10	SP	0	50
2841	CC	10	HF	0	466
2841	PC	15	HF	0	75
2842	PC	13	SP	0	65
2851	CC	5	HF	0	276
2851	PC	9	HF	0	48
2852	CC	9	HF	0	382
2852	PC	2	HF	0	23
2853	CC	5	CG	0	190
2853	PC	1	CG	0	2
2854	CC	1	HF	0	12
2855	PC	14	SP	0	141
2856	CC	3	HF	0	149

GIS DATA BASE INFORMATION - ALTERNATIVE D

AREA	PRESC	AC	HMETH	GGREEN	GDEAD
5004	CC	3	HF	0	180
5008	CC	3	HF	0	180
5010	CC	8	HF	0	294
5012	PC	6	HF	0	21
5014	PC	8	HF	0	50
5016 5016	CC PC	10 6	SP SP	0 0	408 54
5018 5018	CC PC	21 2	HF HF	0 0	1159 14
5020 5020	CC PC	8 5	SP SP	0 0	1260 49
5022	CC	16	SP	0	804
5024 5024	CC PC	18 2	SP SP	0 0	919 10
5026	CC	6	CG	0	283
5028	CC	9	SP	0	216
5030 5030	CC PC	2 1	SP SP	0 0	82 22
5044	PC	6	SP	0	182
5046 5046	CC PC	1 5	HF HF	0 0	87 170
5048 5048	CC PC	22 12	HF HF	0 0	1742 83
5052 5052	CC PC	5 2	SP SP	0 0	378 48
5056	PC	6	SP	0	236
5058	PC	9	SP	0	269
5062	CC	6	SP	0	174
5070 5070	CC PC	4 6	HF HF	0 0	131 94
5072	CC	2	CG	0	101
5074 5074	CC PC	3 1	CG CG	0 0	125 2
5078	CC	16	SP	0	456
5080	CC	7	SP	0	348

GIS DATA BASE INFORMATION - ALTERNATIVE D

AREA	PRESC	AC	HMETH	GGREEN	GDEAD
5082	CC	22	HF	0	1030
5082	PC	2	HF	0	8
5084	CC	15	HF	0	451
5086	CC	23	SP	0	1090
5088	CC	5	HF	0	132
5090	CC	7	HF	0	218
5092	PC	16	HF	0	217
5094	CC	3	HF	0	83
5094	PC	6	HF	0	9
5096	PC	20	HF	0	263
5100	CC	1	HF	0	30
5116	CC	8	HF	0	629
5118	CC	4	CG	0	206
5120	CC	8	HF	0	478
5122	CC	8	SP	0	607
5124	CC	30	SP	0	1697
5126	CC	14	SP	0	591
5128	CC	15	SP	0	1238
5130	PC	1	SP	0	45
5132	CC	8	CG	0	341
5134	CC	7	SP	0	339
5136	CC	9	HF	0	406
5138	CC	13	SP	0	780
5140	CC	8	SP	0	449
5142	CC	19	HF	0	984
5144	CC	25	SP	0	1469
5146	CC	10	SP	0	206
3148	PC	44	HF	0	1436
5150	CC	14	HF	0	721
5150	PC	2	HF	0	39
5152	CC	8	CG	0	334

GIS DATA BASE INFORMATION - ALTERNATIVE D

AREA	PRESC	AC	HMETH	GGREEN	GDEAD
5156	CC	11	SP	0	584
5156	PC	1	SP	0	14
5238	CC	4	CG	0	161
5238	PC	2	CG	0	26
5240	CC	6	HF	0	250
5240	PC	26	HF	0	217
5242	PC	8	SP	0	90
5244	PC	8	SP	0	63
5246	PC	11	SP	0	97
5248	PC	6	SP	0	216
5250	PC	7	SP	0	147
5252	PC	6	SP	0	244
5254	CC	3	SP	0	179
5254	PC	8	SP	0	73
5256	PC	20	HF	0	114
5264	CC	5	HF	0	324
5264	PC	12	HF	0	95
5266	PC	17	SP	0	200
5268	CC	2	HF	0	94
5268	PC	3	HF	0	44
5270	CC	4	HF	0	259
5272	PC	10	HF	0	68
5274	CC	6	HF	0	465
5274	PC	11	HF	0	31
5276	PC	8	HF	0	200
5280	PC	2	HF	0	14
5300	PC	8	SP	0	13
5390	PC	3	HF	0	71
5396	CC	8	HF	0	434
5400	CC	4	SP	0	207
5402	PC	6	HF	0	153
5404	PC	6	SP	0	42

GIS DATA BASE INFORMATION - ALTERNATIVE D

AREA	PRESC	AC	HMETH	GGREEN	GDEAD
5406	PC	6	SP	0	36
5420	PC	8	SP	0	210
5422	PC	31	HF	0	1222
5432	PC	14	HF	0	439
5434	PC	20	HF	0	606
5436	PC	16	HF	0	406
5438	PC	14	SP	0	336
5440	PC	8	SP	0	122
5442	PC	14	SP	0	355
5444	PC	9	HF	0	236
5446	PC	12	HF	0	260
5448	CC	15	SP	0	655
5450	CC	10	SP	0	581
5452 5452	CC PC	4 2	CG CG	0 0	258 26
5454	PC	6	SP	0	32
5456	PC	6	SP	0	18
5458	CC	6	CG	0	305
5460 5460	CC PC	5 1	CG CG	0 0	84 6
5462	CC	5	CG	0	106
5464	CC	8	HF	0	184
5466	CC	12	SP	0	456
5468	CC	12	SP	0	425
5470 5470	CC PC	15 4	SP SP	0 0	396 16
5472 5472	CC PC	2 6	SP SP	0 0	53 30
5474	PC	20	SP	0	264
5476	CC	11	SP	0	276
5478 5478	CC PC	6 2	SP SP	0 0	183 20

GIS DATA BASE INFORMATION - ALTERNATIVE D

AREA	PRESC	AC	HMETH	GGREEN	GDEAD
5480	PC	18	SP	0	124
5482	CC	8	SP	0	270
5482	PC	2	SP	0	42
5484	CC	2	SP	0	42
5486	PC	6	HF	0	134
5488	PC	12	HF	0	159
5490	PC	6	HF	0	108
5492	PC	8	SP	0	91
5494	CC	10	HF	0	226
5494	PC	1	HF	0	8
5496	CC	11	SP	0	222
5496	PC	1	SP	0	2
5500	CC	14	SP	0	646
5500	PC	2	SP	0	26
5506	CC	2	HF	0	91
5512	CC	5	CG	0	156
5514	PC	36	SP	0	254
5516	CC	11	SP	0	259
5518	CC	21	HF	0	621
5518	PC	17	HF	0	221
5520	CC	2	HF	0	103
5520	PC	22	HF	0	42
5532	CC	3	HF	0	173
5568	CC	1	HF	0	31
5572	CC	11	SP	0	810
5572	PC	10	HF	0	386
5636	CC	4	SP	0	54
5636	PC	5	SP	0	106
5638	CC	5	SP	0	134
5638	PC	3	SP	0	58
5640	CC	4	CG	0	209
9999	CC	15	SP	0	880
TOTALS:		4,677			132,086

HARVEST AREA DETAILED INFORMATION
Derived from
GEOGRAPHIC INFORMATION SYSTEM DATABASE (GIS)

ALTERNATIVE F

DEFINITIONS OF ABBREVIATIONS

AREA Harvest Area number (relates to a specific map location)

PRESC Silvicultural Prescription
- **CC** Clear Cut
- **SH** Shelterwood
- **PC** Partial Cut

AC Area Acres

HMETH Harvest Method
- **CG** Cable Ground Lead
- **HF** Helicopter Full Supension
- **SP** Skyline Partial Suspension
- **SF** Skyline Full Suspension

GGREEN Gross Green volume

GDEAD Gross Dead volume

GIS DATA BASE INFORMATION - ALTERNATIVE F

AREA	PRESC	AC	HMETH	GGREEN	GDEAD
2020	CC	6	SP	0	190
2036	PC	18	SP	0	2
2037	CC	13	SP	0	652
2038	CC	16	SP	0	918
2041	CC	17	SP	132	495
2051	CC	4	SP	0	167
2055	PC	14	SP	0	374
2056 2056	CC PC	3 17	SP SP	0 0	62 514
2057	CC	21	SP	0	818
2058	CC	11	SP	0	600
2059	CC	18	SP	0	534
2060	CC	10	SP	11	370
2067	CC	1	SP	0	38
2073	CC	19	SP	0	811
2077	CC	16	SP	0	694
2078	CC	19	SP	0	1330
2087 2087	CC PC	14 18	SP HF	127 0	542 18
2090	CC	18	SP	0	939
2091	CC	18	SP	0	783
2096 2096	CC PC	13 13	SP SP	0 0	513 74
2097	CC	17	SP	0	445
2100	CC	20	SP	0	634
2154	PC	8	CG	0	319
2260	CC	8	SP	0	370
2270	CC	5	SP	0	182
2272	CC	14	SP	349	184
2274	CC	19	SP	276	670

GIS DATA BASE INFORMATION - ALTERNATIVE F

AREA	PRESC	AC	HMETH	GGREEN	GDEAD
2276	CC	8	CG	18	413
2278	CC	7	SP	31	202
2280	SH	12	SP	0	688
2288	CC	12	SP	0	659
2290	PC	5	SP	0	13
2292	CC	24	SF	907	748
2296	PC	17	HF	0	452
2298	CC	26	SP	726	792
2460	CC	10	SP	100	330
2500 2500	CC PC	19 24	SP SP	0 0	925 313
2502	SH	14	SP	0	677
2510	PC	18	HF	0	318
2512	PC	26	SP	0	97
2513	PC	48	SP	0	376
2514	PC	6	SP	0	115
2516	CC	7	CG	109	94
2518	CC	6	SP	0	234
2520	CC	12	SP	84	470
2522	CC	16	HF	0	657
2524	CC	10	SP	0	382
2526	CC	6	SP	0	279
2528	SH	14	SP	246	241
2530	CC	4	HF	0	144
2532	SH	11	SP	0	441
2534	CC	6	HF	0	234
2536	CC	2	HF	0	84
2540	CC	3	SP	0	153
2542	CC	12	SP	0	599
2544	CC	14	SP	0	696

GIS DATA BASE INFORMATION - ALTERNATIVE F

AREA	PRESC	AC	HMETH	GGREEN	GDEAD
2546	CC	25	SP	0	1240
2548	CC	6	SP	0	266
2554	CC	9	HF	43	354
2556	CC	12	SP	54	462
2558	CC	9	SP	43	374
2560	SH	24	SP	101	1028
2562	CC	10	SP	22	340
2564	SH	10	HF	54	468
2568	CC	3	HF	0	141
2570	SH	2	HF	7	88
2572	CC	5	SP	4	197
2574 2574	CC PC	6 11	SP SP	13 0	248 349
2576	CC	13	HF	0	321
2578	CC	8	SP	0	277
2580	CC	42	SP	0	1442
2582	SH	25	SP	0	1067
2584	CC	8	SP	0	335
2586	CC	2	SP	0	89
2588	CC	12	SP	35	577
2590	SH	2	HF	0	89
2604	PC	65	HF	0	1810
2610	CC	6	SP	0	313
2612	CC	41	SP	0	1794
2616	CC	48	SP	0	2129
2626	CC	24	SP	0	1196
2628	CC	10	SP	0	497
2630	CC	20	SP	0	939
2632	CC	10	SP	0	446

GIS DATA BASE INFORMATION - ALTERNATIVE F

AREA	PRESC	AC	HMETH	GGREEN	GDEAD
2634	CC	24	HF	0	1153
2636	CC	66	SP	0	2790
2682	CC	10	SP	0	478
2684 2684	CC SH	8 11	SP SP	0 0	86 223
2686	PC	20	SP	0	318
2690	SH	4	HF	0	232
2808	CC	3	SP	45	90
2809	CC	5	SP	88	102
2810	CC	1	SP	7	9
2813	CC	9	SP	27	317
2814	CC	10	SP	0	338
2815	CC	35	HF	0	1221
2816	PC	42	SP	0	842
2817	CC	9	SP	0	206
2818	CC	14	SP	0	534
2819	CC	10	SP	0	403
2820	CC	18	SP	0	709
2822	CC	2	SP	27	71
2823	CC	22	SP	0	514
2824	CC	10	SP	0	353
2826	CC	6	SP	0	267
2827 2827	CC PC	1 4	SP SP	0 0	58 10
2841	CC	10	SP	0	439
2851 2851	CC PC	5 9	SP SP	0 0	263 11
2852 2852	CC PC	9 2	HF HF	0 0	358 14
2853	CC	6	CG	0	174
2854	CC	1	SP	0	10

GIS DATA BASE INFORMATION - ALTERNATIVE F

AREA	PRESC	AC	HMETH	GGREEN	GDEAD
5004	CC	3	SP	0	173
5008	CC	3	SP	0	172
5010	CC	8	SP	0	273
5016	CC	10	SP	0	382
5018	CC	23	SP	0	1110
5020 5020	CC PC	8 5	SP SP	0 0	303 29
5022	CC	16	SP	0	762
5024	CC	20	SP	86	886
5026	CC	6	CG	0	267
5028	CC	9	SP	0	192
5030	CC	3	SP	18	97
5048	CC	22	SP	0	1684
5056	PC	6	SP	0	212
5058	PC	9	SP	0	232
5062	CC	6	SP	0	158
5070	CC	4	SP	0	121
5074	CC	3	CG	0	117
5078	CC	16	SP	0	414
5080	CC	7	SP	0	330
5082	CC	22	SP	0	974
5084	CC	15	SP	0	412
5086	CC	23	SP	0	1029
5088	CC	5	SP	0	119
5090	CC	7	HF	0	199
5092	PC	6	HF	0	206
5096	PC	8	HF	0	247
5116	CC	8	SP	0	608
5118	CC	4	SP	0	196
5120	CC	8	SP	0	457

GIS DATA BASE INFORMATION - ALTERNATIVE F

AREA	PRESC	AC	HMETH	GGREEN	GDEAD
5122	CC	16	SP	0	546
5124	CC	30	SP	0	1618
5126	CC	14	SP	0	554
5128	CC	15	SP	0	1221
5130	CC	7	SP	24	27
5132	CC	8	SP	0	320
5134	CC	7	CG	0	321
5136	CC	9	SP	0	382
5138	CC	13	SP	0	746
5140	CC	8	SP	0	428
5142	CC	19	SP	0	934
5144	CC	25	SP	0	1403
5146	CC	10	SP	0	180
5150 5150	CC PC	14 2	SP SP	0 0	688 25
5152	CC	8	SP	0	313
5156	CC	12	SP	13	567
5238	PC	6	SP	0	163
5242	PC	8	SP	0	57
5248	PC	6	CG	0	194
5250	PC	7	SP	0	120
5252	PC	6	CG	0	222
5254	PC	12	SP	0	203
5256	PC	9	SP	0	51
5274	CC	6	HF	0	449
5280	PC	2	CG	0	5
5396	CC	8	SP	0	414
5398	PC	3	CG	0	122
5400	PC	4	SP	0	196
5404	PC	6	SP	0	18
5406	PC	6	SP	0	11

GIS DATA BASE INFORMATION - ALTERNATIVE F

AREA	PRESC	AC	HMETH	GGREEN	GDEAD
5432	CC	14	SP	410	420
5434	CC	20	SP	314	572
5436	CC	16	HF	214	379
5438	PC	12	SP	0	182
5440	PC	8	SP	0	89
5448	CC	15	SP	0	616
5450	CC	10	SP	0	554
5452	CC	6	CG	82	257
5458	CC	6	CG	0	289
5460	CC	5	CG	0	26
5462	CC	5	CG	0	93
5464	CC	9	SP	35	164
5466	CC	12	SP	0	424
5468	CC	12	SP	0	393
5470	CC	15	SP	0	357
5476	CC	11	SP	0	247
5478	CC	8	SP	54	187
5482	CC	8	SP	0	248
5484	CC	2	SP	14	38
5494	PC	12	SP	0	192
5496	PC	12	SP	0	160
5500	CC	14	SP	0	582
5506	CC	2	SP	0	86
5512	CC	5	CG	0	143
5516	CC	11	SP	0	230
5518	PC	28	SP	0	678
5636	CC	4	SP	0	38
5638	CC	5	SP	0	119
5640	CC	4	CG	0	198
9999	CC	15	SP	0	861
TOTALS:		2,566		4,950	91,212